NATURE

No. 4385 SATURDAY, NOVEMBER 14, 1953 Vol. 172

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INDUSTRIAL EFFICIENCY AND SCIENTIFIC RESEARCH

IN opening the discussion on training for management at the British Association meeting at Liverpool, Prof. R. S. Edwards made the suggestion that Counterpart Funds derived from United States Economic Aid might be used for encouraging industrial support of postgraduate training in management by providing half the salaries of industrial candidates accepted for such courses. Behind such proposals lies the belief that the technical backwardness of sections of British industry and their failure to exploit the results of scientific research are due to deficiencies in management, either through failure to employ sufficiently trained men as managers, or through insufficient representation in management of men with a strong scientific or technical background. The Select Committee on Estimates in its recent inquiry into technical education noted the unanimity of view as to the vital importance of technical and commercial education to Britain's competitive power in world markets and the higher productivity of her industries.

Nevertheless, the proposal to use Counterpart Funds (see *Nature*, Sept. 19, p. 528) in this way to increase productivity is not one to be endorsed without careful consideration, particularly in the light of the last report of the Advisory Council on Scientific Policy, and of Mr. Graham Hutton's examination of the effect in their own industries of reports of the returning members of sixty-one productivity teams from British industry which the Anglo-American Productivity Council sent to the United States. Questions much more important than the best means of training managers are involved, and no appreciation for the generosity and altruism of the United States should be allowed to stand in the way of a critical inquiry which bears closely on the health of British industry as a whole. Moreover, not merely the application of the results of research but also the initiation and organization of research appeared to be involved and certain aspects of the relations between industry and the universities.

Mr. Graham Hutton's book, published under the title "We Too Can Prosper: The Promise of Productivity" (pp. 248; London: Allen and Unwin, Ltd., 1953; 12*s*. net), assesses the findings of the teams in the light of information and advice from the Anglo-American Productivity Council and in collaboration with Mr. Geoffrey Crowther, editor of *The Economist*. In spite of the unanimous conclusion of all the teams that a higher output could be obtained in Britain without increasing strain or stress on operatives and with a modest re-equipment programme, mainly by better managerial and trade union methods, the book holds out little hope that the advice of the productivity teams will accelerate the process. Some of the improvements which could quickly increase productivity are simple and homely: Mr. Hutton estimates that re-organization of work alone could achieve a 10 per cent increase in productivity. Such reorganization, however, has to

overcome the inertia and conservation of both management and trade unions and other obstacles inherent in an old industrial system.

The obstacles to better utilization of work are in fact largely psychological and human; but while Mr. Hutton's book may reach a wider public, we must review any proposals to increase productivity and secure the more effective utilization of the results of research and of physical effort in the light of such an attitude. Failure to deal with the root causes of such a climate of opinion can only result in continued frustration and in the waste of resources that could with advantage have been deployed to remove the real obstacles. Imagination and understanding of the human issues are probably the first essentials in arriving at a decision as to the right policy, and that is as true of both sides of industry as it is of government.

The projects for which grants from Counterpart Funds have been proposed cover an extremely wide field. Some are frankly debatable, and, on the face of it, are for things that British industry should be well able to do for itself. Others would seem to be well within our capacity to support if there was only the will to devote resources to the purpose, even if it involved the diversion of resources from some other less essential purpose.

This is the fundamental reason for hesitation in welcoming the proposals of the White Paper for the use of Counterpart Funds. The Select Committee on Estimates, in two reports issued last summer, made it clear that the nation has yet to face frankly and realistically its educational aims and programmes in terms of the resources allocated or available. Neither major political party has yet indicated that it is prepared either to adjust the aims and programme or the resources to be allotted for educational purposes, still less to indicate where else it would make savings in national expenditure to supply the finance or materials. The same position arises in regard to research expenditure, and it has been pointed out in these columns that mere prunings may be quite inadequate to provide for any further increase in national expenditure on scientific and industrial research, however essential. It is probable that that expenditure can only be maintained at an adequate level by reduction of expenditure in other sectors, like the social services, where it is highest.

The danger is thus that these proposals for the use of Counterpart Funds may merely postpone an inevitable choice and, in postponing, make a reasonable—if unpleasant—decision even more difficult. Moreover, in themselves, it is arguable that some of the suggestions are damaging to British self-respect and self-reliance. Almost half a million pounds is to be spent on advisory services which will bring to the notice of individual firms improvements in modern technique. Of this, £150,000 will be spent through the Department of Scientific and Industrial Research broadly in implementing the policy of securing the more effective utilization of the results of research on which both the Advisory Council for Scientific and Industrial Research and the Advisory Council on Scientific Policy laid stress in recent reports. Some of it, however, goes to trade and industrial associations which exist to perform such services, primarily for their individual members. Whether or not it is right to subsidize such services in this way, doubts may be entertained as to the efficacy of such expenditure: a high return in terms of public advantage is unlikely.

Such expenditure through the Department of Scientific and Industrial Research may do no more harm than enable the Government to delay decisions for which the Advisory Council has pressed hard but fruitlessly in at least two successive reports. That objection could equally be brought against the sum of just under £600,000 provisionally allocated for research. The usual objections to sponsored research cannot well be made here: the specific studies for which grants are proposed are based, so far as economic research is concerned, on proposals already advanced by universities and research organizations. Those contemplated in social research are to be planned and co-ordinated by the two Committees on Human Relations in Industry and on Industrial Efficiency in Industry recently set up by the Lord President of the Council to advise the Department of Scientific and Industrial Research and the Medical Research Council. In both fields the detailed research projects are to be defined in discussions with the universities and the research institutes.

It can, of course, be urged that the results of such research will be published and made fully available in the United States and elsewhere as well as in Great Britain. That could also apply to the programme of research on innovation and the development of new ideas, the flow of scientific and technical information to industry and its relation to innovation and industrial efficiency, on the economics of re-equipment and on the measurement of productivity and the causes of variation of industrial efficiency, for which £75,000 has been set aside. Indeed, industry in other countries may once again prove quicker to apply whatever is of value in the results of such research than British industry. Moreover, it is possible that one factor in the slowness of some sectors of British industry in applying the results of fundamental research is that those sectors have borne no direct responsibility for the financial support of such research.

If this is true, doubts as to whether the proposals in the White Paper represent the right means for increasing our investment in research are likely to grow; nor is it wise to assume without closer inquiry that the half-million pounds provisionally allocated for education and training is the most appropriate means for endowing chairs or readerships in the universities or for creating teaching posts in industrial engineering at technical colleges. The provision made for postgraduate scholarships and other scholarships in this way is scarcely open to question; but the procedure is at variance with the universities' well-known objections to ear-marked grants. In view of the recommendation in the last report from the University Grants Committee that the system of ear-marked grants should now be discontinued, it is interesting to note that while the University Grants

Committee was consulted in drawing up the industrial section of the programme, there is no indication that it was also consulted in framing the proposals for expenditure on education and training.

The White Paper states that the projects selected for grant were chosen "as being likely to contribute to the development of the national economy by reason of the industry or field of studies to which they were related and the probable effectiveness of the programme of work suggested, and as not being likely to cause a continuing burden on the Exchequer at the end of the programme". This is probably the most important sentence in the White Paper, and since for the reasons given above it is doubtful whether the most effective means have been chosen for achieving the declared objectives, the Government incurs at least the suspicion that the real reason for the proposals lies in the final words. They are an attempt to expand research and training, without the clear thinking and hard decisions which must accompany any real attempt to allocate further national resources to the universities and other institutions for higher education and research, and to the Department of Scientific and Industrial Research.

Such suspicions would be less reasonable if the Government had given any real signs of having a definite policy so far as either education or research is concerned, or if either major political party had indicated a readiness to face the facts of the situation. While, however, political parties refuse to recognize that the allocation of adequate resources to either education or research is likely to involve increasingly the curtailment of national expenditure on other social services or inroads on the standard of living, at least until the international situation and the economic position of Britain permit some reduction of expenditure on defence and of export priorities, it is unlikely that a considered policy in respect of education or research will be evolved. The frustration and waste to which the reports of the Select Committee on Estimates and the recent reports of the Department of Scientific and Industrial Research have borne witness are likely to continue.

The generosity of the United States should be unhesitatingly acknowledged and welcomed; but reservations must be made as to the wisdom of the Government's proposals to ear-mark the funds in the way indicated. For the reasons given, it might well be wiser for the Government, in accepting the aid, part of which is allotted conditionally for "purposes intended to encourage a healthy and expanding economy by promoting the productivity of industry and by stimulating competition", to have devoted it to such purposes generally rather than specifically, and in ways that were less open to suggestions either of 'easy money' or of evasion of constructive thought. In terms of the current expenditure of Great Britain on university, technological and technical education and on scientific research at the universities and in government and independent institutions, £3,000,000 is not an excessive sum, and under wise direction could do much good. It is large enough, however, to cause distortion and to do harm without such direction, and the implications of the whole situation merit examination both by the Advisory Council on Scientific Policy and by the Parliamentary and Scientific Committee.

The latter body could possibly do something to initiate the all-party approach to the question of the national investment in research and education which may well be essential before either political party can be expected to adopt measures so unpopular as the curtailment of expenditure on social services in the absence of an attempt to explain its reason and necessity. Agreement on that step would still leave room for difference of opinion as to the allocation of resources on different levels of education or in different fields of research; but it should also help to remove such irrationalities as that seen at the Trade Unions Congress in the dissatisfaction that the widening of the opportunities for university education, by drawing off more of the abler school-leavers, has diminished the prospects of promotion to managerial levels from the shop or factory floor.

The last report of the Advisory Council on Scientific Policy was specifically concerned with investment in research, and suggested that a significant increase in the volume of such investment is the most effective single measure that could conduce to a greater exploitation of science by industry; nevertheless, the Advisory Council was equally aware that an increased investment in technological education, if not also in the science departments of the universities, could also assist. While recognizing that it is particularly an increase in the amount of risk capital that is required, the Advisory Council, like the Government in framing the programme for the expenditure of Counterpart Funds, gave scarcely enough attention to the means proposed for achieving its ends. The Advisory Council did not accept the usual argument that current rates of taxation directly discourage expenditure on research and development, though it admitted that a major improvement in investment cannot be expected without a big change in Government policy. In relying on institutional research and investment and such means as the National Research Development Corporation to bring about a radical improvement in British industry, the Advisory Council appeared to lose sight of the essential factor, just as does the White Paper on Counterpart Funds.

The real problem is to create in industry the receptivity to new ideas and the readiness to experiment and to take risks, both in research and in development. That cannot be done by transferring to government departments or like institutions the responsibility for identifying technical needs and taking the risks involved in promoting technical development; Sir Henry Tizard made that very clear in his Messel Memorial Lecture last year. The Advisory Council's proposals, like those for the use of Counterpart Funds, do nothing to decrease the tendency for some sectors of British industry to continue to leave most of the risk to be borne by the Government.

More co-operation between industry and the Government in development may be required through such devices as the research associations and the

National Research Development Corporation; but the responsibility for enterprise and adventure should rest, by and large, on industry. As Prof. R. S. Edwards, like the Advisory Council, pointed out in an earlier article on industrial research and development in Great Britain, the Government's primary responsibility is a negative one, namely, to see that our economic arrangements and the level and incidence of taxation do not weight the scales too heavily against the supply of capital for risk-bearing ventures. On the positive side, the Government's task is also to see that neither whole industries nor individual firms are shielded by restrictive agreements or associations from the consequences of lack of enterprise and failure to utilize new knowledge, and that full opportunity and encouragement is given to those willing to enter and venture on these fields. A prime task of government should, in fact, be to secure the mobility that industrial development demands. The defects of British industry largely flow from its excessive rigidity and the increasing extent to which units and individuals are screened from the consequences of their own mistakes or inertia. In post-war Britain, the concern to mitigate the consequences of technological change and development tends not so much to the science of social adjustment advocated by Lord Stamp as to discouragement of development generally. Not merely the pattern of nationalization, but also the general climate of opinion in wide sectors of society, are averse to change and all that is implied by the developments required to safeguard Britain's economic future.

There is, of course, much room for constructive thought regarding the whole organization of research and development in Great Britain. Prof. Edwards's suggestions for association of the universities, the colleges of technology and the research associations in meeting the increased demand for sponsored research merit examination, giving due weight to the dangers and difficulties to which Sir John Stopford and others have directed attention. The same institutions and government research establishments have also a contribution to make to higher technological education and the supply of managers as well as technologists, and the possibilities of co-operation are far wider than was indicated in the British Association discussion at Liverpool. American experience may have something to teach us in both respects, and the inquiries recently conducted by the National Science Foundation into the use of Federal funds in support of research and development have a close bearing on evolution of a policy in Great Britain also.

The report of the Advisory Council on Scientific Policy and the White Paper on the use of Counterpart Funds would be less disturbing if there were any evidence that the Government has a policy for research and development. All the evidence at present suggests that such issues are evaded, and that science is treated with less and less respect in the counsels of the State. The task of securing the adequate use of science by industry in Great Britain has not been seriously considered by the Government during the past four or five years. The first step is that of encouraging fluidity, of making industry less rigid and more open to pressure to seek and use new knowledge. The prime responsibility rests with the Government, though it will still remain for industry to show that it possesses the determination, enterprise, courage and imagination to use opportunities which may be afforded. That again is partly a matter of industrial recruitment, and here government policy in the allocation of resources for university and technological education is an essential factor in securing an appropriate flow of trained man-power. Finally, on government policy depends the wise deployment of our resources in material, finance and man-power between government organizations, the universities and other independent research institutions, and industry itself, so that the national effort is in balance. Not only is such a balance necessary, but also conditions must be such that they attract a sufficient number of the nation's most creative minds, and allow them to work under the most fruitful conditions; thus implementing, so far as possible, the application of the new knowledge wherever it is required, in industry or in the service of the national welfare.

COMPARATIVE ANATOMY AND TAXONOMY OF THE LEMURS AND LORISES

Primates

Comparative Anatomy and Taxonomy. 1: Strepsirhini. By Dr. W. C. Osman Hill. (Edinburgh University Publications, Science and Mathematics No. 3.) Pp. xxiii+798+24 plates. (Edinburgh: At the University Press, 1953.) 105*s*. net.

DR. W. C. OSMAN HILL has undertaken the considerable task of assembling in a work of reference "the more scientific aspects" of what is known about lemurs, monkeys and apes. Vol. 1, which is the volume under review, deals with the lemurs and opens with a general section on the diagnostic characters and classification of the whole order of Primates. Like most contemporary students, Dr. Hill accepts the definition of a Primate laid down by St. George Mivart in 1873 but, in addition, provides information about other general characteristics (for example, placentation, physiology of reproduction, dentition). Then follows an account of the geological and geographical distribution of the Primates, and of their taxonomy and phylogeny. No new ground is broken; but Dr. Hill does not accept Gaylord Simpson's recent proposal to subdivide the order into the two sub-orders Prosimii and Anthropoidea, and to include in the former the Tupaiidae and Tarsioidea. Instead, he reaffirms Pocock's previous subdivision of the Primates, from which he completely excludes the Tupaiidae, into the two "grades", Strepsirhini (lemurs and lorises) and Haplorhini (essentially monkeys and apes), and classifies the Tarsioidea as a sub-order of the Haplorhini, rather than with the Strepsirhini.

A general introduction to the Strepsirhini then follows. It begins with a list of the lemurs and lorises, and goes on to a fairly detailed and systematic

account of their general anatomy. Information is also provided about gestation, placentation and development. The natural behaviour of lemurs and lorises is discussed, and a special section deals with what Dr. Hill calls "Mental Development".

The next hundred and fifty pages of the book are devoted to the sub-order Lorisoidea of the Strepsirhini, consisting of the two families Lorisidae and Galagidae. The sub-order Lemuroidea, with its eight constituent families, takes up the five hundred pages which follow. The same pattern of treatment is followed throughout. Thus, a general section defines the external characters, the systematic anatomy, the development, the behaviour and the taxonomy of the whole sub-order of Lorisoidea; more specialized sections are devoted to its two families; still more specialized sections deal with each of their constituent genera; and these in turn are followed by sections describing each species. Interesting historical data are also provided. While the amount of detail within each section varies with our knowledge and ignorance, the pattern of treatment which Dr. Hill has followed necessarily results in some repetition.

The whole text is generously illustrated with line-cuts and half-tones. There are thirty-four plates, about half of which illustrate living animals. Useful maps are provided to show the distribution of the various species, and there is a sixteen-page list of references and an index.

The preparation of the book must have demanded enormous enthusiasm and endless patience, and there can be no question that Dr. Hill has rendered a service to his fellow-students of the Primates. The volume is, however, uneven, not only because of gaps in our knowledge, but also because Dr. Hill seems less at home in some sections of his book than he is in those which deal specifically with anatomical and taxonomic matters. In the latter he has incorporated most of what other workers have published, including descriptions of the bones and dentition of fossil lemurs. His own contributions have been mainly concerned with the taxonomy and external characters of living Primates, especially of their external genitalia, and it is understandable that considerable space, and a very disproportionate number of the illustrations, are devoted to the latter topic. But this is at the expense of what many workers might regard as more important issues (for example, the skeleton, muscles, nervous system, etc.). The sections dealing with "the scientific aspects of primate behaviour", including the few called "Mental Development", show that we still know very little about the lives and behaviour of lemurs and lorises.

How much of the information that is given about the history of our knowledge of lemurs and lorises is the fruit of original historical research is difficult to judge. Some clearly is, but some is obviously not. For example, Dr. Hill tells us that Madagascar, the home of the lemurs, was well known to the Ancients, and that it was known to the Greek geographer "Ptolemy, (third century B.C.)" . . . under the name Menuthias. There appears to be at least two errors here[1]: the period of Ptolemy, the geographer, was the middle of the second century A.D., not the third century B.C.; and the name Menuthias, which first appears in the Periplus, an anonymous work of the first century A.D., relates to the coastal islands of Zanzibar or Pemba. Several decades later, Ptolemy correctly noted that Menuthias lay near the coast, but his figures for latitude and longitude wrongly placed it far out to sea. Hence the subsequent confusion of Menuthias with Madagascar.

In the area covered by the book, one man's fact is not infrequently another's bone of contention, and Dr. Hill does not entirely succeed in his avowed purpose of avoiding discussions of a controversial nature. To take one example, he scarcely begins to justify the case for excluding the Tupaiidae from the taxonomic relationship with the Lemuroidea which has been argued by such workers as Kaudern and Le Gros Clark, and which Simpson recognizes in his classification. Another debatable point is the statement that the way in which the menstrual cycle, which is a primate characteristic, is differentiated from the œstrous cycle of the non-primate mammal is that in the latter uterine bleeding occurs at the time of ovulation, whereas bleeding in the menstrual cycle occurs at the end of the luteal phase. In point of fact, uterine degeneration associated with bleeding is the exception rather than the rule in the œstrous cycle of non-primate mammals.

There are, unfortunately, other examples of debatable statement. Thus, considerable space is given to a description of the genitalia of the common brown lemur, *L. fulvus*, and of the mongoose lemur, *L. mongoz*, Dr. Hill writing that "there is no sexual attraction between females of the latter species and males of the former" and that the two species are "probably incompatible". He also states that "the differences in the sexual organs are probably to be attributed to divergent evolutionary trends based upon their incompatibility". Whatever is meant by this last sentence, it is on record that hybrids between the two species have occurred. Dr. Hill also speculates, without data, about the periodicity of breeding in the Lemuridae and Galagidae, but dismisses actual records which are contrary to his beliefs. He writes, too, that the breeding season of lemurs is the same in captive as in wild specimens, and that it is not affected by environmental changes. But there are indications that lemurs, like practically all other mammals from the southern hemisphere, switch their breeding seasons when moved to captivity in the northern hemisphere. If this were not so, they would be very exceptional mammals. Dr. Hill also refers to the existence of a sexual skin in the Strepsirhini, without giving any more basis for this belief than he does for his description of the spleen as one of the ductless glands.

Nevertheless, he has provided a book which students of the Primates, both to-day and to-morrow, are certain to consult before they undertake any researches on lemurs. One can only regret, therefore, that all its contents do not sustain the scholarly impression which the book first gives. Readers will particularly regret the frequent omission of the names of the authorities on which various statements are based; for a work of reference fails in a major purpose when those who use it cannot bring their own critical powers to bear on the sources of particular pieces of information it incorporates.

Obviously these shortcomings are an indication of the very exacting task which Dr. Hill has tried to fulfil. He has undoubtedly done much better than did D. G. Elliott in the much criticized three-volume "Review of the Primates" which was published in 1913, and which Dr. Hill's new work supersedes. But some readers may well consider that Dr. Hill could have served his fellow students better if, in addition to his taxonomy, he had devoted the bulk of his attention to a detailed account of the structural

anatomy of, say, a member of each of the families of the Lorisidae and Lemuridae rather than spread himself thinly over the whole field. It is to be hoped that any subsequent volumes on the Primates which Dr. Hill may produce will improve on, as well as perpetuate the good points of, the present volume.

S. Zuckerman

[1] See Thomson, J. Oliver, "History of Ancient Geography" (1948).

POLYCYCLIC NITROGEN HETEROCYCLES

Heterocyclic Compounds

Edited by Robert C. Elderfield. Vol. 3: Polycyclic Derivatives of Pyrrole; Polycyclic Systems with One Nitrogen Common to Both Rings; Pyrindine and related Compounds. Pp. vii+442. 96*s*. net. Vol. 4: Quinoline, Isoquinoline and their Benzo Derivatives. Pp. vii+674. 136*s*. net. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1952.)

THE ambitious scheme to produce a modern treatise on the chemistry of heterocyclic compounds has made considerable headway with the appearance of these two volumes. They will probably have an even wider appeal than Vols. 1 and 2 (see *Nature*, **168**, 618; 1951), for as Prof. R. C. Elderfield says in his preface to Vol. 3, "the chemistry of the polycyclic nitrogen heterocycles containing one hetero nitrogen atom has probably been the object of more intense investigation than any other single group in the broad field of heterocyclic chemistry". It is with these polycyclic nitrogen compounds that Vols. 3 and 4 are concerned. The major part of Vol. 3 (274 pages) is devoted to a most timely and interesting chapter on indole and its derivatives by P. L. Julian and two collaborators. Prof. Elderfield's contribution is far from being restricted to editorial duties. He has himself written the 343-page chapter on quinoline (Vol. 4), and is part author of the chapters on *iso*-indole and on pyrindine, quinindine and their derivatives (Vol. 3). A chapter by H. R. Ing on bicyclic systems with a nitrogen atom common to both rings completes Vol. 3, and Vol. 4 contains also chapters on *iso*quinoline (Walter J. Gensler), the acridines (Adrien Albert), and phenanthridine and benzoquinolines (L. P. Walls). The names of the authors are a sufficient assurance of the authoritative character of the work. So vast a field of organic chemistry as heterocyclic compounds can be surveyed with authority only by a multiplicity of authors, and it is inevitable, therefore, that there should be a certain lack of uniformity in treatment.

Comprehensiveness is not claimed. In particular, there is no detailed treatment of the considerable groups of alkaloids which are derived from the ring systems dealt with in the volumes under review. This omission is entirely justifiable. There are other excellent modern works dealing with alkaloids, and their inclusion in the present work would have made it unwieldy, besides unduly delaying its progress. Although alkaloids are not dealt with systematically, there is incidental reference to many of them; for example, in connexion with quinuclidine, pyrrocoline and pyridocoline, *iso*quinoline and phenanthridine.

The chapter on indoles gives a survey of numerous methods for their synthesis and a discussion of the mechanism of some of the reactions involved. There is a description of the preparation of various classes of indole derivatives, mostly those substituted in the pyrrole ring. Natural indole derivatives are discussed, including heteroauxine, gramine and tryptophan, and there is a valuable discussion of the metabolism of tryptophan. It would have been useful to have had also a section giving a general account of the properties and reactions of indole and its simple derivatives, although doubtless most of the information which could have been introduced in such a section is scattered through the chapter in its present form.

Reference is made in the prefaces to delays at the proof stage and to the fact that it has not been possible to bring the subject-matter completely up to date. Although unfortunate, this is doubtless unavoidable, especially in fields such as those covered by the present volumes, where new developments are constantly taking place. The section on the stereochemistry of the tropane group, for example, would have been presented rather differently if it had been possible to include the recent work of Prof. G. Fodor.

The books are well printed and produced and scarcely any misprints have been noticed. The numbering of the acridine ring has given some difficulty, and it is interesting to note that the editor has not felt bound to adopt current American practice. Both he and his collaborators are to be congratulated on a most valuable contribution to the literature of organic chemistry.

J. W. Cook

A FRESH APPROACH TO INTERMEDIATE BOTANY

Intermediate Botany

By L. J. F. Brimble. Fourth edition entirely revised and rewritten in collaboration with Dr. S. Williams, and with the assistance of Dr. G. Bond. Pp. x+505. (London: Macmillan and Co., Ltd., 1953.) 20*s*. net.

THE authors have rewritten "Intermediate Botany" by L. J. F. Brimble and brought it up to date. They have set out to provide a book suitable for candidates for the General Certificate of Education (Advanced Level) and for candidates for first-year university examinations such as those for intermediate science, arts, pharmacy, agriculture, horticulture and medicine. They were obviously faced with various fundamental decisions, and they can scarcely be expected to have produced a volume that is beyond criticism by teachers in at least some of the wide fields for which they have attempted to cater. For example, there will always be two schools of thought as to whether one should begin the session with *Pleurococcus* or with a whole plant of groundsel. The authors have in some ways chosen the best of both worlds, because they have devoted the first thirty pages or so to an interesting introduction in which they review the subject of botany and the plant kingdom as a whole. Then, when they start the real work they throw in their lot with the groundsel school, except that they use rosebay willowherb for variety.

In the next three hundred pages (approximately) the Angiosperm is treated very fully. The physiology and anatomy are both well presented in the text though the diagrams vary in quality. For example, on p. 253 the stamens of the buttercup are not shown to be extrorse; part of the diagram of meiosis on

p. 266 is not a happy choice. Elementary students find this subject difficult, and really clear drawings of a good size are essential to the elucidation of the facts. This Angiosperm section as a whole is, however, very well done and the material will be of great value to students.

The emphasis in any course must depend largely on the teacher; but one might be justified in feeling that the lower plants have been sacrificed to some extent in this volume. They occupy a total of approximately one hundred pages out of five hundred, which appears to be less weight than most teachers would expect to give them in well-balanced courses.

The book concludes with a chapter on ecology and a section on the families of flowering plants. In the latter, the need to cater for a wide range of students has tended to force the inclusion of a large number of families, where one would have preferred, for some courses, a more detailed treatment of fewer families.

On the whole, however, the book will be very valuable for the upper forms of grammar schools and for first-year students in universities. It brings out the breadth of the subject and its inter-relationship with human beings and world economy. All the way through the authors have refrained from "putting words like monochlamydeous in a series of adnate parallelograms" and have written the text in an attractive manner that will lead the student to read more widely by stimulating interest in different aspects of the subject. Suggestions for practical work occur at frequent intervals, and the material as a whole is presented with a freshness that will stimulate both teacher and student. The book is well produced with clear print and a comprehensive index.

LILY NEWTON

COMETS AND METEORS

Comets and Meteor Streams

By Dr. J. G. Porter. (International Astrophysics Series, Vol. 2.) Pp. xi+123+6 plates. (London: Chapman and Hall, Ltd., 1952.) 28*s*. net.

IN 1947 when the Physical Society conference was held in Manchester to discuss the new radar methods of investigating meteors, Dr. J. G. Porter gave a lecture on the subject. The present book is an expansion of this lecture and provides the most up-to-date information on the subject of comets and meteors (very little is said about meteorites, but many now think that these have originated in some way entirely different from that in which comets and meteors had their origin). The first chapter gives a general survey of the subject and deals with such matters as the increase in cometary discoveries, the mass, size, spectra, luminosity, etc., of comets, and the influence of light pressure, ending with a short reference to Whipple's hypothesis, suggested in 1950, on the origin of comets. Chapter 2, on the orbit of a comet, is almost entirely mathematical and will prove very helpful to amateur astronomers who are engaged in calculating ephemerides by the use of standard formulæ but may not always know how these formulæ are derived. A short reference is made to the computation of orbits of comets from three observations, but the author very wisely does not attempt to deal with the methods generally used for computing cometary orbits—a problem which he describes as "one of singular complexity" and which lies outside the scope of the book. Chapter 3, which is illustrated by a number of diagrams, is on cometary statistics and deals with such matters as distribution of perihelion distances, the three types of comets (parabolic, hyperbolic and elliptical), families of comets, distribution of eccentricities and aphelia, the number of comets and their origin. A brief survey is made of the theories of the origin of comets, but Dr. Porter offers no opinion on their relative merits, though after describing Oort's explanation he suggests that in the future greater importance may be attached to the study of "new" comets, "and of the perturbations by planets and stars which these comets have suffered in the past".

Chapter 4, on perturbations, will be read with great interest by members of the British Astronomical Association who belong to the Computing Section, of which Dr. Porter is the director. This Section does very valuable work in various ways—not least in computing cometary perturbations and compiling ephemerides for a number of periodic comets. This chapter shows the principles underlying the method, and a useful example of the application of mechanical quadrature is given for a body falling freely in the earth's gravitational field. Table 13 shows how the Cowell scheme is used in the case of the Pons–Winnecke's Comet during the years 1948–49 of its revolution, and other useful information on perturbed orbits is provided in this chapter.

The last three chapters deal with meteors, Chapter 5, on meteor streams, giving a general survey on such matters as visual observations, the number of meteors, modern methods of observation (including photography and radar), perturbations of meteor streams and the effect on the elements of their orbits. In the next chapter is shown how the orbit of a meteor stream is computed when the position of the radiant is known and also how corrections are made in this position when the earth's attraction and the aberrational effects due to the diurnal rotation are taken into account. While the latter is very small and can often be ignored, the former can be considerable, especially when the speeds of the meteors relative to the earth are small and the radiant is close to the horizon. The reverse problem—the determination of the radiant of a stream associated with a comet—is also dealt with, and Table 19 gives a list of cometary meteor radiants, a maximum distance of 0·1 astronomical unit between the earth's orbit and the comet being admitted.

At the end of Chapter 7, which is the last one and deals with meteor velocities, after examining all the available evidence, including photography and radar, on the velocities of meteors, Dr. Porter says he is convinced that all meteors, like comets, are members of the solar system with the exception of a relatively small number of both meteors and comets which are forced into slightly hyperbolic orbits by planetary perturbations. While there are still some who think that a fairly large proportion of the sporadic meteors have decidedly hyperbolic velocities—far exceeding parabolic velocity—the general opinion now is that errors of observation or in timing the flight or other causes are responsible for this view and that meteors must, on the whole, be accepted as members of the solar system.

This book will be extremely helpful to amateur astronomers; and even professional astronomers, many of whom have never found time for an intensive study of meteoric problems, will read it with great interest and advantage.

M. DAVIDSON

Inorganic Chemistry

An Advanced Textbook. By Prof. Therald Moeller. Pp. ix+966. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1952.) 80*s*. net.

THE term "advanced" of the sub-title of this book is of special note. The author writes for graduate and undergraduate students, and he assumes that the customary descriptive matter of the advanced text-book is known—so he omits most of it. This permits him to concentrate on the significant chemistry of the substance in question and on its general relationships. Furthermore, he maintains that those sections of physical chemistry which determine properties and behaviour are an essential part of inorganic chemistry. The discussion of these fundamental physical factors forms his Part 1 (pp. 369). The contents of this part include: atomic and molecular structure, radioactivity, the Periodic System, valency, the chemical bond, oxidation potentials, acid-base concepts, complex ions and co-ordination compounds, and non-aqueous solvents. The treatment of these principles is done more thoroughly than in many a text-book of advanced physical chemistry; and the co-ordination of the relevant factors to the interpretation of chemical action is a praiseworthy piece of work. The descriptive matter forming Part 2 is divided into eleven chapters on the basis of the Periodic System. The chemistry of the elements and of their chief compounds is considered in the light of the conclusions established in Part 1; the emphasis, therefore, is on unifying factors and interrelationships and not on the details of preparations and properties. There are an appendix on naturally occurring isotopes and one on the disintegration series. The book is well documented. The carefully planned and skilful fusion of facts and theories into an ordered system herein given should do much to promote the study of inorganic chemistry.

Methods of Logic

By Prof. Willard van Orman Quine. Pp. xxi+264. (London: Routledge and Kegan Paul, Ltd., 1952.) 16*s*. net.

IT is characteristic of the present 'climate' in which advanced mathematics is developing in the United States to find comprehensive texts dealing with logic, foundations, the theory of sets, and so forth appearing fairly rapidly. This readable book is an excellent example, and one which may well exert a wide influence. The subject-matter is covered in four main parts—truth functions, uniform quantification, general theory of quantification and, finally, glimpses beyond. There is also a select bibliography.

As one might expect, some of the most illuminating remarks occur in connexion with the discussion of identity, and in an exceptionally lucid introduction to the algebra of classes and relations. An example of the former (p. 208) is:

Cicero = Cicero, Cicero = Catiline, Cicero = Tully.

Of these, evidently the first is trivial, and the second is false, but the third is in fact true, in the sense that two different assemblages of letters denote one and the same man. Perhaps the most interesting contrast here is between this kind of identity and the traditional reluctance of the grammarian to allow that there is such a thing as a true synonym. John Ruskin, for example, would never admit that a perfect synonym existed. It is to the credit of the modern logician that his symbolism has helped so much to clear the air, as well as directing attention to the distinction between the sign and the thing signified, be it a specific entity or a universal.

F. I. G. Rawlins

Electromagnetic Fields

Theory and Applications. By Prof. Ernst Weber. Vol. 1: Mapping of Fields. Pp. xvi+590. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 80*s*. net.

IN this text-book Prof. E. Weber gives a very complete presentation of the various methods—analytical, numerical, and graphical—which are available for the mapping of static electric and magnetic fields. Analytical methods are given the most detailed attention, and there are separate chapters dealing with fields of simple geometry, two-dimensional analytical solutions, and three-dimensional analytical solutions. Numerical and graphical field-plotting methods, such as the relaxation method and the method of curvilinear squares, are treated in a single chapter, and there is in addition a chapter giving a brief outline of experimental methods of field-plotting.

The introductory sections of the book, in which the fundamental relationships for electrostatic and for magnetostatic fields are developed, have been prepared with particular attention to clarity and accuracy of exposition. Much of the material of the earlier chapters is appropriate to undergraduate courses in physics and electrical engineering; but, taken as a whole, the book constitutes an authoritative work of reference for the advanced student or research worker.

The book utilizes the rationalized M.K.S. system of units, and one of the four appendixes gives a table of conversion factors to other unit systems. References are given to a large number of the most important original sources upon which the author has drawn.

Between the Tides

By Philip Street. Pp. 175+32 plates. (London: University of London Press, Ltd., 1952.) 15*s*. net.

"THIS book", states the preface, "is intended primarily for the young naturalist", and there is no doubt that those interesting themselves in seashore life for the first time will find it both helpful and stimulating. The information given is, on the whole, accurate and well selected, a little being derived from recent scientific publications. The text is written in a plain and elementary style well suited to its purpose; it is free from facetious anecdotes and that attitude of wide-eyed wonder which has disfigured so many natural-history books intended for the young. The work is enlivened with lengthy quotations from Gosse, Couch and other writers of the past century, from which the young reader will be made aware that there is a historical background to seashore studies. There are a number of factual errors and some misleading statements; but these are not unduly numerous and are mostly of minor significance. In the text there are some forty line-drawings which the beginner will find useful in spite of their crudity. The book is lavishly illustrated with many photographs reproduced in half-tone on art paper. The photography is competent; but the subjects are all too often preserved specimens out of water. Some of the photographs are from life, and a few of these show real technical ability.

D. P. Wilson

VISITORS' TABLES AT COLONIAL FISHERIES RESEARCH STATIONS

By Dr. C. F. HICKLING, C.M.G.
Fisheries Adviser to the Secretary of State for the Colonies

THE Colonial Office is establishing a number of fisheries research stations at suitable points in the British Colonial Empire. These stations are particularly concerned with the application and adaptation of existing knowledge, methods and techniques of fishery and of marine and freshwater biological research to Colonial problems, and this work involves, in addition to general studies of the ecological background, detailed studies of the life-histories of the fauna and of the factors which influence their growth, distribution and migration. The whole of the initial capital expenditure for these stations is being met from central research funds made available under the Colonial Development and Welfare Acts. The same source usually provides for one-half of the recurrent costs for an initial period of five years, the remaining half being divided between the territories in the region served by the research station.

The work of these stations is reviewed by the Colonial Fisheries Advisory Committee, which advises the Secretary of State for the Colonies. Apart from Colonial Office members, this Committee consists of the following: Mr. J. Croft Baker, chairman, British Trawlers' Federation, Ltd.; Dr. G. E. R. Deacon, director, National Institute of Oceanography; Mr. T. S. Leach, chief inspector of fisheries, Ministry of Agriculture and Fisheries; Dr. C. F. A. Pantin, Department of Zoology, University of Cambridge; Dr. G. Reay, superintendent, Torry Research Station (Department of Scientific and Industrial Research); Mr. F. S. Russell, director, Plymouth Laboratory; Dr. Ethelwyn Trewavas, British Museum (Natural History); Mr. R. S. Wimpenny, Fisheries Laboratory, Lowestoft (Ministry of Agriculture and Fisheries); and Prof. C. M. Yonge, Department of Zoology, University of Glasgow. Brief reports on the work of the stations are included in the annual series of reports entitled "Colonial Research" (for example, for 1951–52: Cmd. 8665; H.M.S.O.; 6*s*. 6*d*.).

Each station is locally administered by the Government in whose territory the station is situated, except that, in East Africa, administration is in the hands of the East Africa High Commission. Local committees, on which the interested and contributing territories are represented, discuss research policy with the directors. These research stations have accommodation for visiting scientists; and for hydrologists and biologists who may be interested in taking advantage of these facilities, the following brief account of the research stations is offered.

The earliest research station to be established is at Jinja, on Lake Victoria. Mr. R. S. A. Beauchamp is director, and there is a staff of four research officers. A study is being made of the distribution and life-histories of the fishes of Lake Victoria and of the other East African lakes, with special reference to species of *Tilapia*. Speciation problems in the *Haplochromis* group of Cichlid fishes are being investigated. A study has been made of the Chironomid and Chaoborid 'lake flies', and the life-history of these insects has been related to that of the elephant snouted fish (*Mormyrus*), which feeds principally on their larvæ. Recently, the spawning grounds of *Mormyrus* have been located with the aid of the echo-sounder; these fish spawn in deep water over rocks emerging from the mud. Ripe fish have been caught, and the eggs artificially fertilized.

The hydrology and chemistry of lake waters, with special reference to the production of plankton, form an important part of the research programme.

Work on aquatic molluscs is increasing our knowledge of the snail-borne helminth diseases of man, domestic animals and fish. A number of new snail vectors of *Schistosoma* have been recorded, and infection experiments carried out on them. As part of these investigations, a very complete type-collection of East African freshwater aquatic snails has been made, and is housed at Jinja.

The Station has two motor launches and a mobile laboratory for field-work.

Air passages and accommodation can be provided for visiting scientists who wish to work at this laboratory. Very valuable work has already been done by such visitors, which benefits and supplements that of the research station staff. Visitors include Dr. Margaret Brown, Dr. H. B. Cott, Mr. R. Ross, Mr. J. T. Saunders, Dr. G. S. Carter, Mr. D. E. Moorhouse and Dr. W. Holmes.

At Zanzibar there is a newly established Marine Fisheries Research Station. The laboratory was officially opened by H.H. the Sultan of Zanzibar in April 1953. The director is Dr. J. F. G. Wheeler, and two of the four scientific officers on the establishment are at work. Research, so far, has been mainly on the big surface fishes, such as the Carangids, Scombrids and Tunas, which are caught by multiple trolling, using a wide variety of experimental lures. At a later stage, when the full scientific staff is at work, hydrography, plankton and the biochemistry of mangrove muds and fish products will be included in the programme. The station has the use of a number of brackish-water fish-ponds, in which the chemical and biological changes undergone by sea-water when impounded over mud can be studied.

Full research facilities are provided. The Station has a 70-ft. diesel research drifter, and a 'landrover' for local transport. Zanzibar is situated in an area of coral reefs and mangrove swamps, and very deep water comes to within a few miles of the island.

The British West African territories are served by the West African Fisheries Research Institute at Kissy Dockyard, near Freetown in Sierra Leone. The Institute is placed on low cliffs overlooking the Freetown estuary, and backed by the Sierra Leone hills. This is one of the few points in West Africa where the coastal lands are high and where the foreshore is rocky. Seaward of Freetown there is a 60-mile wide continental shelf, which descends steeply from a depth of about 70 fathoms.

The director of the Institute is Mr. Angus Taylor, and the full establishment of scientific officers is six, of whom four are now at work. The station has three research vessels, namely, a 110-ft. steel motor trawler, and two 31-ft. motor launches. The station buildings are adapted from the headquarters, stores, workshops and living quarters of the former naval

base. A freshwater research substation is now being established at Birnin Kebbi in Northern Nigeria.

Research is being done on the hydrology and biology of the Freetown estuary, with special reference to the fisheries, and a routine trawling survey from the motor launches is in progress. There is a very varied fauna of fish and invertebrates on bottoms of sand, shells, gravel and fine mud. Studies of bottom soils include estuarine muds and mangrove swamps, and a start has been made on the physical, chemical and biological changes which follow the empoldering and draining of such swamps.

With the large research vessel, a trawling and hydrographical survey of the seas lying off the British West African territories has begun, but has been interrupted by mechanical defects in the research trawler. Trawling was carried out to depths greater than 100 fathoms, where little or no fishing has hitherto been done. When the research trawler returns to service, these long-range surveys will be done throughout the year.

A little work has been done on the freshwaters of Sierra Leone; these are of an acid character and the territory as a whole is deficient in lime.

The Northern Rhodesia–Nyasaland Joint Fisheries Research Scheme has to cover waters separated as widely as Lake Tanganyika in the north, Lake Nyasa in the east, the Zambesi and Kafue Rivers in the south, and Lakes Bangweolo and Mweru, with their swamps, and the Luapula River, in the south and west. Consequently, though its headquarters will be on Lake Bangweolo, at Samfya, where a laboratory and houses are being built on a bluff overlooking the lake, the research unit must be mobile. This autumn it is starting a two-year survey of Lake Nyasa. Buildings are being prepared, and a research launch acquired. The scientific officer in charge is Mr. P. B. N. Jackson, and there is an establishment of three research officers.

At an earlier stage of development are the Marine Research Stations at Singapore and Hong Kong. Dr. F. D. Ommanney is director of the Singapore station, and Mr. J. A. Tubb is director of the Hong Kong station. The building of a laboratory and houses at Singapore has been delayed; a research vessel is being sought. Two of the establishment of three research officers are in training; one has recently undertaken a short mission to Barbados to study the fishing for flying-fish. The Research Station at Hong Kong is in association with the Department of Zoology of the University of Hong Kong, and will be staffed by graduates of that Department. A small research vessel has been laid down. Finally, provision has been made for a station for fundamental research into fish farming. A suitable site has yet to be found.

The Research Stations at Jinja (freshwater) and Zanzibar and Freetown (marine and brackish water) are now in operation, and provide research facilities for visiting workers, who will be welcomed. In certain cases, a part of the expenses (except salary) of a visiting scientist can be defrayed from funds available to the Research Stations. These Stations, being situated where seasonal changes are slight by comparison with temperate climates, and where there is a very wide range of ecological conditions, offer unusually good research opportunities. Applications and requests for information should be addressed, either to the Directors, or to the Fisheries Adviser, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

INTERNATIONAL CONFERENCE ON THEORETICAL PHYSICS

MEETING IN JAPAN

I BELIEVE that the proposal to hold a conference in Japan under the auspices of the International Union of Physics was first made at the General Assembly of the Union in Copenhagen during 1951; certainly the proposal had the strong support of the late president of the Union, Prof. H. A. Kramers. Suggestions were originally made for a conference of rather limited scope, on statistical mechanics or on field theory; but it seemed to everyone concerned that this, the first important conference on physics ever to be held in Japan and the first real opportunity for Japanese physicists to meet those of other countries, should cover a much wider field. It was decided in the end to arrange a conference to include most branches of theoretical physics on which work is being done in Japan, including field theories, meson theories, molecular structure and the physics of the solid state, and also to hold the annual executive committee meeting of the Union in Tokyo on the same occasion.

The conference was organized by the Science Council of Japan, with the collaboration of Kyoto University where the main sessions were held, and by the Physical Society of Japan. About sixty physicists from outside Japan attended, including thirty from the United States, six each from France and Great Britain, and others from Australia, Belgium, Denmark, Germany, India, Italy, Korea, Mexico, Netherlands, Sweden and Switzerland. About ten times as many Japanese physicists took part. Much of the heavy cost of bringing the foreign scientists to Japan was defrayed by special grants from Unesco and from the Rockefeller Foundation, while arrangements were made by the United States Government Agencies for bringing most of the scientific workers from that country. Within Japan, the cost of living and of travelling from place to place was borne by the organizers of the conference, money being contributed by the Japanese Government, by industry and commercial organizations, by newspapers and by many private individuals.

The main conference opened in Tokyo with a formal session, the delegates then travelling to Kyoto for the scientific meetings. These were held in three sections in parallel, the first on nuclear physics and field theory, and the other two covering various aspects of molecular physics, statistical mechanics and the physics of the solid and liquid states. In addition, more limited symposia were held in Kyoto and other centres, and in hotels in holiday resorts, on nuclear resonance phenomena, polymers, dislocations, latent image theory and on liquid helium, to mention only some of them.

The discussions on field theory and nuclear physics were attended by the largest numbers, both of Japanese physicists and of the visitors from other countries. (I am indebted to Prof. R. E. Peierls for a description of the work in this section.) For the visitors the most important result of the conference was that they learned to understand the ideas behind some outstanding Japanese papers that they had seen in print but had not adequately compared with their own methods. Probably the experience was mutual. It is, of course, a difficult time for field theory, since we are in doubt about the basic equations and are also without sufficiently powerful methods of solving

them to be sure of their consequences. There was naturally much discussion on methods of approximation, including the idea that, for an approximate meson theory of nuclear forces, one should treat the interaction at large and at small distances differently. At small distances a phenomenological treatment might suffice, whereas at large distances conventional perturbation theory might be reasonably good. Such an approach was first proposed in Japan by Taketani and his collaborators, and later developed independently and more extensively by Lévy at Princeton. Other novel approximations which were discussed included an application by Tomonaga and others of his 'intermediate coupling' method to scattering problems, a new use of variational methods by Sawada, and an attempt by Brueckner, in describing the nucleon–meson interaction, to allow for the distortion of the meson wave by the presence of the nucleons. Some time was devoted to up-to-date reports on the experimental situation both in nucleon–nucleon interactions and on new elementary particles. It is evident that there is a wide range of facts to be described by a complete theory, but as yet no real clue as to how to construct one. New attempts to modify the theory included Yukawa's 'non-local' theory which contains for each field 'internal' as well as the ordinary space–time co-ordinates, and this gives one freedom to describe many types of particles in the same field. However, the theory is still too general to give specific results, and it also contains troublesome infinite degeneracies.

Another interesting modification proposed by Pais also uses additional variables; but these relate not to a second four-dimensional space-time but to the surface of a sphere, the rotations of the sphere being connected with isotopic spin. In this way one finds these rotations and the isotopic spin combining like ordinary angular momentum and spin, and this suggests a classification of some of the recently discovered particles. One may then interpret the absence or weakness of some processes not otherwise forbidden by a parity selection rule in this new space.

There was some discussion of theories with 'non-local interactions' in which one tries to avoid singularities by replacing the usual point interaction by actions over small but finite distances. Reports by Møller, Peierls and C. Bloch led to the conclusion that none of the existing forms of such a theory is capable of removing the singularities.

The last two sessions went briefly into problems of nuclear structure and nuclear reactions, and here one is on much firmer ground, since, in spite of uncertainty about the basic laws, a great many features of nuclear theory are qualitatively well understood.

In the session on the solid state, I was impressed with the quality and extent of the Japanese work on slip lines and their examination with the electron microscope. This is fitting, since the quantitative study of slip lines started in Japan with Yamagouchi. At the conference and at the additional symposia, first-class work was described by Fujiwara in Hiroshima, by Takamura in Kyoto and by T. Suzuki and Fujita in Sendai. One of the most interesting discoveries during the past few years in this field is the fact that marked work-hardening of metal crystals occurs only when they slip on more than one set of planes. In Great Britain we became aware of this owing to experimental work carried out here and in Germany since 1949; but we now find that the main facts were established by Fujiwara in Hiroshima during the War and published in the Japanese language. There is also much interesting work in Japan on the theory of dislocations. Here I think that one can still claim that the first steps were taken in Europe and America; but the Japanese physicists, in spite of an almost complete absence of personal contact with other countries, have acquired a detailed knowledge and appreciation of the published literature and are now making important contributions of their own. I was particularly interested in H. Suzuki's modification of the model of the Frank–Read source, which shows how the plane of slip could shift by one lattice plane for each dislocation produced, especially in view of the convincing experimental evidence from several centres in Japan that this actually occurs. A slip line within a crystal may thus have a thickness equal to the slip distance.

In an article of this length it is impossible to describe more than a few of the subjects discussed. The study of F-centres arouses great interest in Japan; and I vividly remember an informal session in which Prof. Seitz expounded for hour after hour all that he knew on this subject to a large and eager group that simply could not have enough. In fact, this was the impression that we all had—of large numbers of young workers, of great eagerness and talent. There is no doubt that fundamental research greatly attracts the youth of Japan, and that, in spite of very inadequate financial rewards, research is what they want to do.

Two other aspects of the conference deserve mention. One is the great amount of space devoted to it by the Japanese press and the popular interest that it excited. Every day the newspapers carried long articles about the proceedings of the conference, photographs of the delegates and accounts of their views on many subjects, scientific and otherwise. Reporters accompanied us to garden parties, to receptions and on excursions to the temples and gardens of Japan, and often became our very good friends, telling us what we wanted to know of the life of the country and showing us things that we might not otherwise have seen. To the question that we were always asked, what are the most important results of the conference, we could only answer that through it the Japanese physicists and those of the rest of the world have got to know each other, to appreciate each other's work, and to establish mutually stimulating contacts. This was certainly true, and made the conference well worth while.

The other point is the warmth and the charm of the hospitality that was showered upon us. Everything that could be done was done to make our stay enjoyable and comfortable, to show us the best of the old Japan and of the new Japan. At each city the leading citizens came forward to welcome us, flowers and gifts were pressed upon us, cars and interpreters put at our disposal. I expect that both sides learned much from the customs of the other. I remember how, at a farewell dinner, after which the Western delegates had spoken at some length, Prof. Tomonaga referred to the good and the bad that Japan had taken from the West, including that bad Western custom, the after-dinner speech. The Japanese custom is to give a few words of welcome before the guests sit down to dinner and no afterwards. On the occasions during our stay when this was done, with the elegant dishes of the country spread out before us, there was certainly no temptation to speak too long. Perhaps this is one of the customs that we might learn from Japan.

N. F. Mott

TWELFTH INTERNATIONAL CONGRESS OF LIMNOLOGY

THIS Congress, like the preceding ones (see *Nature*, 162, 623; 1948) held under the auspices of the International Association of Limnology (President: Dr. Gunnar Alm (Sweden)), opened at Cambridge on August 20 and terminated at Windermere on August 30. The first to be held in Great Britain, it attracted nearly three hundred people belonging to about thirty-five different countries. On the first evening those taking part gathered at a reception at Trinity College, while on the last afternoon at Cambridge the Master and Fellows of Christ's College entertained them at a garden party. On the evening of August 21, Prof. D'Ancona (Padua) delivered the first Baldi Memorial Lecture, founded by his countrymen in memory of the late Prof. E. Baldi. Prof. D'Ancona, who spoke in English, took as his theme the stability of lake plankton communities, a topic to which Baldi and his co-workers made manifold contributions. On the evening of August 25, Dr. E. Windle Taylor (Great Britain) gave an account of the reservoirs of the Metropolitan Water Board; on August 22, Dr. J. W. Jones (Great Britain) showed a cinematograph film of salmon spawning, while other films relating to fisheries were shown on the evening of August 24.

Upwards of a hundred papers were read during the scientific sessions at Cambridge, but only some of them can be referred to here. Many discussed from one point of view or another topics that are momentarily in the forefront of limnological investigation. Papers dealing with temperature-relationships and circulation in lakes attracted much attention. While C. H. Mortimer described the effects of the earth's rotation on the internal wave pattern, B. Dussart (France) dealt with the influence of inflowing water and sublacustrine springs on thermal stratification and discussed heat-absorption and nocturnal radiation from the surface, a subject considered by H. Charnock from the meteorological point of view. A paper by H. Neumann (Israel) dealt with the second minimum of evaporation which occurs during the period of greatest heating in lakes of middle latitudes. E. S. Deevey (United States) and E. Gessner (Germany) reported on temperature-relationships in tropical South American lakes, and K. Vaas on those of shallow ponds in Indonesia. Various German speakers contributed papers on the classification of lake-types, while E. Teiling (Sweden) reported on phytoplankton indicators in this connexion.

Lake sediments were considered from many different angles. G. E. Hutchinson (United States) gave a highly stimulating account of investigations of the carotenoid pigments and amino-acids present in them, while E. S. Deevey emphasized the importance of palæolimnology as a tool in studying the geographical distribution of the organisms recognizable in the sediments. Sediments also entered largely into discussions on productivity. F. R. Hayes (Canada) described experiments demonstrating the role of bacteria at the mud-water interface on the uptake of radiophosphorus and suggested that artificial increase of the area of the bottom might have the same effect as addition of nutriments (fertilization). D. S. Rawson (Canada) laid emphasis on the shape of the basin as a factor influencing productivity in large lakes. E. A. Thomas (Switzerland) reported the results of monthly estimations and analyses of sedimented material, while H. Järnefelt described similar observations made in southern Finland. H. Dammas (Belgium) described the important contribution made by the phytoplankton to sediments in shallow lakes of the Congo, while J. Symoens (Belgium) gave an account of tufa deposits due to Chironomid larvæ, associated with *Phormidium incrustatum*. The bottom fauna was dealt with by K. Berg (Denmark) and F. Lenz (Germany), while J. H. Mundie (Great Britain) discussed the distribution of Chironomid midges in a Thames reservoir.

As regards other aspects of productivity, W. Ohle, in considering the rapid eutrophy of many North German waters, pointed out that even purified sewage effluents contribute materially towards mineral enrichment of surface waters, while a paper by G. A. Prowse (Sudan) discussed the contribution of the flora as a whole to the productivity of a water. W. Rodhe (Sweden) reported on the probable role of minute and partly heterotrophic green algæ in subarctic lakes in maintaining during winter a zooplankton of about the same magnitude as is found in summer, and G. E. Fogg discussed the importance of polypeptides excreted by algæ in relation to productivity.

Among papers dealing directly with plankton, mention may be made of those of J. Rzóska (Sudan) on that of the White Nile, which attains a maximum during the accumulation of water above the dam south of Khartum; of V. Tonolli (Italy), who considered the fate of zooplankton washed into rivers from the surface waters of lakes; of W. Schmitz (Germany), on the occurrence of water-flowers in flowing waters; of J. F. Talling, on the light-relations of the phytoplankton; and of M. Shilo (Israel), on the use of ammonium sulphate in the control of the toxin-producing phytoflagellate *Prymnesium*. O. Ravera (Italy) and U. Røen (Denmark) discussed seasonal variation in reproductive rate of pelagic Copepods. R. Margalef (Spain) discussed the influence of higher temperatures on morphology of freshwater organisms. A. A. Aleem (Egypt) described the use of triphenyltetrazolium chloride in the measurement of plankton populations, while A. van der Werff (Netherlands) reported on a new method for cleaning diatoms using hydrogen peroxide and potassium permanganate.

Many speakers dealt with aspects of the distribution of freshwater organisms. S. Stanković (Yugoslavia) considered speciation in Lake Ohrid. H. B. Hynes (Great Britain) and S. G. Segerstråle (Finland) discussed the distribution of *Gammarus* in Britain and Scandinavia respectively, J. Illies (Germany) emphasized the importance of Plecoptera owing to their restriction to definite temperature ranges and speeds of current, while K. H. Mann dealt with the factors determining the distribution of leeches, and A. G. Dahm (Sweden) gave an account of the recent immigration into Europe of the Planarian *Dugesia tigrina*. C. Kosswig (Turkey) discussed the marine element in the fish-fauna of freshwater lakes near the Sea of Marmara. Other speakers considered aspects of the introduction of fish. P. Vivier and E. Hubault discussed the causes of the lack of success in introducing Salmonidæ into French waters, E. G. Calderon dealt with the introduction of pike into Spain, J. R. Dymond gave an account of the introduction and spread of *Salmo trutta* and *Cyprinus carpio* in Canada, and D. Hey (South Africa) described the culture, especially of bream, in the final effluent from a sewage works.

Of other papers dealing with fish, mention may be made of those of S. Runnström (Sweden), who described the damage to roe of char resulting from the winter-lowering of the water-level in an impounded lake; of H. D. Slack (Great Britain), dealing with factors affecting the survival of *Coregonus* eggs; and of E. D. Le Cren with those conditioning survival of perch after hatching in Windermere.

On the botanical side A. Lundh-Almestrand discussed the distribution of diatoms in Scanian lakes in relation to their geological structure, F. Hustedt (Germany) gave an account of the influence of temperature on the diatoms of solfataras in Salvador, B. Knudsen dealt with the distribution of *Tabellaria* in the Lake District, while G. Lohammer (Sweden) discussed the introduction of foreign macrophytes.

On the applied side O. Jaag (Switzerland) and D. M. Newitt dealt with general aspects of pollution, F. T. K. Pentelow and J. R. H. Allan with its effects on the distribution of fish, and R. W. Butcher with organisms indicative of stages in recovery from pollution. T. Braarud (Norway) discussed pollution in the Oslo Fjord, while C. J. Rasmussen described pollution by silage juices in Denmark. H. Jakob and M. Nisbet (France) gave an account of experiments on the toxic effects of derivatives of ammonium compounds on algæ and fish, while K. Wuhrmann (Switzerland) and D. W. M. Herbert discussed the influence of various factors on the toxicity of poisons to fish. E. Hubault (France) considered toxicity in relation to molecular structure, while A. B. Wheatland dealt with the influence of traces of oxygen in bringing about absence of sulphides in polluted estuaries.

Various British workers treated of matters concerned with sewage disposal. S. Baines *et al.* described the correlation between the peritrichous ciliate population and the quality of the effluent from activated sludge, H. Painter discussed the factors affecting the growth of fungi in percolating filters, while T. G. Tomlinson considered means of controlling their growth. E. Weise described the use of effluents in German agriculture and W. Husmann gave an account of recent methods of effluent purification in Germany.

Other speakers dealt with water supply. E. Mercier (Switzerland) described improvements in the water of a eutrophic lake resulting from artificial subsurface aeration, A. Guelin (France) discussed the role of bacteriophage in self-purification, and J. Wautier (France) described experiments demonstrating the importance of the biological film in sand filters in retaining *B. coli*. A. T. Palin discussed chlorination, while L. A. Allen, dealing with a new method of estimating numbers of fæcal bacteria in a sewage effluent, referred to their rapid decrease which is not accounted for by dilution.

At the final session in Windermere, the present officers of the International Association of Limnology having indicated their desire to retire, Prof. F. E. Fritsch was elected president and Dr. T. T. Macan general secretary. During the opening session at Cambridge, Naumann Medals were awarded to Prof. Lenz (Italy) and Dr. L. Findenegg (Austria).

Visits to Wicken Fen, the Norfolk Broads, the Luton sewage disposal works, and the Water Pollution Research Laboratory at Garston were arranged during the days spent at Cambridge. The journey to Windermere was made by coach, and occupied three days, with visits to the valleys of the Wharfe and Ure, Wensleydale, Ladybower Reservoir (Bamford), and the sewage works of Birmingham at Barston and Minnworth and of Bradford. During the two days spent at Windermere, one was devoted to inspection of the laboratory of the Freshwater Biological Association and of the experimental hatchery and fishponds at Wraymires, the other to tours in the Lake District. A small number of members visited the Rivers Avon and Test in a pre-congress excursion, while about a hundred took part in a four-days excursion into Scotland after the end of the Congress, visiting the Glasgow University Field Laboratory on Loch Lomond, the Brown Trout Research Laboratory and the Tummel-Garry hydroelectric installations at Pitlochry, and returning via Inverness, Loch Ness and Fort William to Glasgow. A small party then proceeded on a seven-days excursion in Ireland.

F. E. Fritsch

A FOSSIL HUMAN MANDIBLE FROM A LEVALLOISO–MOUSTERIAN HORIZON IN CYRENAICA

By Drs. C. B. M. McBURNEY, J. C. TREVOR and L. H. WELLS

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IN 1947 and 1948, and again in 1951 and 1952, expeditions sponsored by the Department of Archæology and Anthropology at Cambridge visited northern Cyrenaica to study the Pleistocene geology and prehistoric archæology of the Gebel Akhdar coastline[1]. Since the region had been largely unexplored from this point of view, the work of the first two seasons was concentrated on establishing so far as possible the outlines of the geological and archæological sequences during the Pleistocene and their correlation. The final report on it is now in the press. The two following seasons, in 1951 and 1952, were largely devoted to the investigation of a site discovered at the end of the 1948 season—the Haua Fteah or Baker's (literally Dough-Kneader's) Hole.

The Haua Fteah Site (C. B. M. McB.)

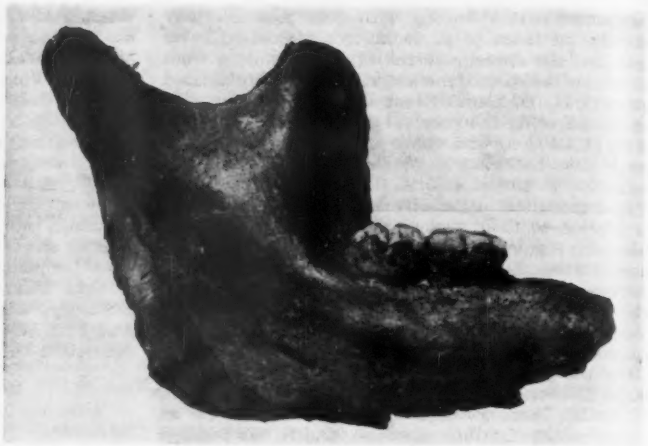
The fossil human mandible discussed below was found at Haua Fteah in August 1952. Despite its incomplete state, the specimen is of special interest owing to the exceptionally clear evidence of geological dating and archæological associations peculiar to the site. This consists of a vertical shaft-like cavity, oval in plan and 80 yd. in minimum diameter, originally partially or wholly closed at the top by a dome-shaped roof. Apparently as a result of its situation close to the shore forming the northern margin of the limestone plateau which constitutes the Gebel Akhdar, about half this roof has been eroded away. The remaining roofed-in portion of the shaft is roughly semicircular in shape and 80 yd. in diameter; the seaward part is open to the sky. Sediments in the seaward part are probably to a large extent subaerial in origin and would appear to have been carried under the overhang as they formed,

partly by the action of occasional floods and rain-wash in the spring. This would explain the remarkably regular horizontal stratification observable in a sounding-trench opened in the roofed-in area, which has now reached a depth of 28 ft.

The roofed-in area is regularly inhabited at the present day, and it seems to have been so in the past throughout the period represented by the deposits thus far exposed. Reading from top to bottom, these present the following archæological and geological indications. Recent and Roman occupational debris occurs from 0 to − 4 ft. From − 4 ft. to − 7 ft. numerous flint artefacts and sherds of rough pottery represent a Neolithic culture with some points of resemblance to Miss Caton-Thompson's Neolithic stage of the Fayum. No pottery or pressure-flaked implements are found below − 7 ft., but from − 7 ft. to − 8½ ft. a relatively high proportion of very minute microlithic tool types is met with. Below this, again, the bigger tool forms, such as large backed-blades, become progressively more common down to − 16½ ft. Beneath a sterile zone further assemblages at − 18 ft. show a typical Levalloiso–Mousterian industry which continues to be recognizable down to the lowest point reached at − 28 ft. The mandible was found among an assemblage of food-bones bordering a hearth at − 23 ft.; it was thus covered by a deposit of at least 5 ft. containing typical Levalloiso–Mousterian cultural debris. An interesting feature already noticed in other Levalloiso–Mousterian finds in this region is their remarkably close resemblance in most details to the corresponding industries in Palestine.

On the geological side, a change in the character of the deposits can be shown to coincide approximately with that of the industries. From − 8½ ft. to − 15 ft. the deposits are marked by a very high proportion of angular fragments of limestone which owe their origin to thermoclastic weathering of the walls and roof of the cave. Above − 8½ ft. these become progressively rarer, while below − 16 ft. they are virtually absent. From − 17 ft. to − 28 ft. there is a great increase in the frequency and extent of stalagmitic concretions, rare above this zone.

The climatic interpretation suggested by Dr. R. W. Hey, who examined the section at the end of the excavation, is that the lower portion represents a phase of relatively temperate and damp conditions, followed by one of dry conditions with well-marked winter frosts that gradually gives way to the dry temperate conditions of the present time. As to the absolute dating of these two phases, it would appear that neither can be correlated with the two major climatic phases of early Würm date previously recognized in the area, namely, one of damp temperate conditions followed by a period of winter frost-action with low rainfall, since the second of these is associated with Levalloisian industrial remains. Moreover, if the last-mentioned phases can, as appears highly probable, be correlated with the two early Würm phases recognized in southern Italy by A. C. Blanc[2], there is every reason for placing the Levalloiso–Mousterian zone at Haua Fteah that contains the mandible *no earlier* than the second Würm interstadial.



Medial aspect of the Haua Fteah jaw (natura size)

The Haua Fteah Jaw (J. C. T. and L. H. W.)

The fragment consists of the left ascending ramus and portion of the body with two teeth of the permanent dentition, M_2 and M_3, still in place. Its outer surface is crushed and uneven but the inner surface is well preserved. The crown of M_2 is much worn and the cusp-pattern therefore obscure. The wisdom tooth, however, seems to have erupted only a short time before the subject's death, since, apart from a certain amount of attrition on its proximal margin, the occlusal surface is unabraded. It bears five cusps but displays the modern cruciform rather than the archaic classical *Dryopithecus* pattern and has no discernible anterior or posterior fovea. The largest cusp is the anterior buccal (protoconid), and the European Neandertal 3–2 contact, noted by Gregory in all the permanent lower molars of the Le Moustier youth and in the two of the Ehringsdorf child that have erupted[3], does not exist. Instead, the general form of M_2 is similar to the corresponding tooth of the 'Neandertaloid' woman, Tabun I, from Mount Carmel in Palestine[4]. Skiagrams indicate the absence of true taurodontism as described by Tratman[5]. The dimensions of the teeth, although somewhat small, do not provide an adequate basis for sexual assessment. On the other hand, a crude analysis of the metrical features of the ramus by the method of assigning 'marks', used by Pearson and Bell and by Morant[6], suggests that the sex of the person to whom the mandible belonged was probably female. Slight as it is, the evidence at our disposal tends to identify the owner of the jaw as a young woman, aged perhaps between eighteen and twenty-five.

Morphologically, the Haua Fteah fragment is distinguished by the square appearance of the ascending ramus, which is emphasized by the shallow sigmoid notch and low blunt coronoid process. This appearance of the ramus seems to be due chiefly to a building-out of its anterior border, that is, the portion to which the temporal muscle is attached. It is further accentuated by the relative lowness of the body of the mandible where it joins the ramus; the height of the ramus above the alveolar plane is,

by contrast, great. Despite the shallow sigmoid notch, the articular surface of the condyle is boldly convex.

In the best-known specimens of European Neandertal mandibles (La Chapelle-aux-Saints, La Ferrassie, La Quina, Krapina) the ascending ramus is conspicuously narrower than in the Haua Fteah fragment; but that of the presumably female Malarnaud jaw would assume a very similar appearance if its anterior border were built out to the same degree. All these European Neandertal mandibles display a broadly truncated angle; although the posterior border in the Haua Fteah fragment is corroded, it does not clearly indicate such a truncated outline. In this respect the specimen more closely resembles the Mount Carmel mandibles. Among these the Tabun mandibles, and especially the female Tabun I, are nearest to the Haua Fteah fossil, a fuller account of which will be published by us in the *Journal of the Royal Anthropological Institute*, Vol. 83, Part I.

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OBITUARIES

Prof. M. Lugeon, For.Mem.R.S.

At Lausanne on October 23, Maurice Lugeon passed away, having reached the ripe old age of eighty-three. In him we lose one who may fairly be regarded as the chief participant in the most exciting achievement that stands to the credit of geological science.

Spectacular results regarding Alpine structure had indeed been obtained before Lugeon's day, but in 1893 something of a different order was introduced through Schardt's announcement of the far-travelled nature of the Prealps that extend from Lake Geneva to Lake Thun. Lugeon was closely connected with Schardt's discovery, and afterwards did more than anyone else to develop the ideas thus liberated, and to provide a comprehensive interpretation of the Alps as a whole. In 1885, Lugeon, only fifteen years old, began to accompany a junior assistant engaged upon the official geological survey, 1 : 80,000, of the French portion of the Prealps. By 1891 he had advanced to the position of rucksack-carrier to Renevier, the principal surveyor in his district. This resulted in an introduction to the director, Michel-Lévy, who, impressed by the part played by the 'petit homme' in a field conference, tried his mettle as an independent mapper. The result was satisfactory, and Lugeon was retained for some years to work for the French survey. In 1893, along with Renevier, he led an excursion of the Swiss Geological Society to the Chablais district upon which he was engaged. Here he demonstrated, on new fossil evidence, the existence of an important area which has peripheral Trias and Jurassic resting almost everywhere upon Tertiary strata. For him, in his youth and inexperience, the structure seemed to be a mushroom-fold, in which older rocks were supposed to have risen centrally through younger, thereafter to spread outwards in all directions. This was a structural mistake, as Marcel Bertrand warned him in conversation; but his demonstration of age relations provided Schardt with an essential clue to the correct interpretation. By 1895 Lugeon was almost certain that Schardt was right, and we find him closing a great memoir on the "Région de la Brèche du Chablais" with the words: "It is with doubt, mingled, however, with conviction, that I finish this work". Next year he declared himself completely satisfied.

Among the multitude of his subsequent papers we may perhaps single out for special gratitude "Les grandes nappes de recouvrement des Alpes du Chablais et de la Suisse", which was circulated in proof during a triumphant excursion, 1901, and "Les Hautes-Alpes calcaires entre la Lizerne et la Kander", 1914–18. One of his last services to science dates from 1950, when he presided over a 'réunion géologique en Provence pour commémorer le cinquantenaire des œuvres de Marcel Bertrand'. It was good to find the old hero defending some of Bertrand's tectonic discoveries, all too readily abandoned by the present generation.

In the utility field, Lugeon has also won distinction as a consultant on dam sites, both at home and abroad.

Lugeon's many honours include, in addition to the Wollaston Medal of the London Geological Society, the following appointments: honorary professor of the University of Lausanne, where for many years he taught; foreign member of the Paris Academy of Sciences, and of the Royal Societies of London and Edinburgh; Grand Officier of the Legion of Honour, France.

He is survived by a widow and son.

E. B. Bailey

Mr. A. W. Ashby, C.B.E.

Arthur Wilfred Ashby, whose death occurred at Oxford on September 9 at the age of sixty-seven after a few days illness, had a world-wide reputation as a student of agricultural organization and rural social life. Born at Tysoe, in Warwickshire, he was the eldest son of Joseph Ashby, a farm-worker and smallholder, a Methodist lay-preacher, and a friend and colleague of Joseph Arch, the organizer of the first Agricultural Labourers' Union. Arthur Ashby was educated at the village school, proceeding thence after a few years work on his father's holding to Ruskin College, Oxford, as the first holder of the Charles Buxton Scholarship, recently endowed, tenable by the sons of farm-workers. In 1911, he was awarded the University diploma in economics and political science, and in the following year the Board of Agriculture awarded him a research scholarship in agricultural economics; its terms provided for two years study at Oxford in the newly-founded Institute for Research in Agricultural Economics, to be followed by a third year spent in some approved research centre overseas. In Ashby's case the First World War restricted the choice to one of the American universities, and it was to Wisconsin that he went.

Returning to Oxford in 1915, an honorary Fellow in political economy of Wisconsin, he began a study of the history of allotments and smallholdings which was published by the Institute in 1917, and although it was supplemented by later writers, it remains the classic on the subject. A period of work for the Board of Agriculture followed, during which he was

occupied mainly in the Food Production Department; but he had a large share, also, in the provision of data for the early work of the first Agricultural Wages Board, set up in 1917. He returned to Oxford in 1920, remaining there until 1924, when he was elected lecturer in agricultural economics in the University College of Wales, Aberystwyth, an appointment which was raised to a professorial chair five years later. Thus he continued until 1946, when he returned once again to Oxford as director of the Agricultural Economics Research Institute, to retire finally in December last.

All through his life, Ashby showed an immense capacity for work. His early experiences as a member of a farm-worker's family at the end of the past century, and his own achievement of an education from village school to university standard in the days when this was not an easy accomplishment, had given him a deep and lasting interest in education and its provision on a wider scale for those capable of profiting by it. At Aberystwyth he created the school of agricultural economics, and when that was established as the foremost place of study of the subject in the United Kingdom, he went on to found a postgraduate school which achieved an international reputation, attracting graduate students from all parts of the world. This interest was further developed during his last years, when the research institute at Oxford became the Mecca of students from the Commonwealth, the United States and other places. Subsidiary to this work was his interest in administration. So early as 1919 he had been a member of the Royal Commission on Agriculture, and three years later he served on a departmental committee on prices of farm produce. Marketing problems became his particular study, especially co-operative organization, and when the co-operative movement in English agriculture suffered its lamentable collapse in 1920, more credit was due to him, probably, than to any one supporter that the Welsh Agricultural Organization Society survived, to extend its influence in Welsh rural life in subsequent years.

Other bodies on which Ashby served with distinction were the second Agricultural Wages Board, set up by the first Labour administration in 1924, and the councils of agriculture for England and for Wales. He did much to promote the good of the Young Farmers' Clubs movement, and the efforts of the Women's Institutes to secure better conditions in rural social life.

From this record it will be apparent that Ashby's main preoccupation was the human side of the work that offered, and that his direct contributions to economic research and its literature were subordinated to it. Nevertheless, the influence which he exercised on the development of his subject cannot be over-estimated, and he was an inspiration to all those—and they were many—with whom his life brought him into contact. C. S. Orwin

Mr. James Fairgrieve

The death of James Fairgrieve at the age of eighty-three removes one of the few remaining members of the band of reformers whose work has given us the modern concept of geography, and who have seen in their lifetime its firm establishment throughout the schools as a subject of major cultural value and in all British universities as a discipline of comparable worth—all largely as a result of their own activities. A son of the manse, he was born at Saltcoats in 1870 and enjoyed the advantages of a peripatetic Scottish education at Saltcoats, Ardrossan and Glasgow before proceeding as an Exhibitioner in both cases to Aberystwyth and to Jesus College, Oxford, where he graduated M.A. His early interests were classical and mathematical, and for periods in his early life he held the posts of mathematics master at Kelso and Campbeltown before appointment as head of the New Southgate High School in London. But he fell under the same spell as Herbertson, with whom he worked at Oxford, Halford Mackinder, under whom he studied at the London School of Economics, B. B. Dickinson of Rugby, and H. J. Fleure, to appreciate in the reform of geography the keystone of a new humanist teaching.

In 1907 Fairgrieve gave up his headship to become geography master and second master at the William Ellis School in North London. There he established what was perhaps the first 'geography room'—a well-equipped room set apart for the teaching of geography and which he regarded as important a necessity as a laboratory for chemistry or for physics. His view in this regard has now become fully accepted and the provision of such a room in schools is standard practice. He was forty-two when he was appointed to the post of lecturer in education with special reference to geography at the old London Day Training College for Teachers, afterwards the Institute of Education of the University of London. There he was destined to wield a remarkable influence for nearly a quarter of a century (1912–35) over successive generations of teacher-trainees taking their teacher's diploma after graduation in the University of London. In those years he seemed to change little. Tall, cadaverous, with a slight stoop, an unruly shock of iron-grey hair and an unkempt walrus moustache, he talked to his classes as if they were not there, yet with a burning enthusiasm which never failed to impress and endear. A martyr to digestive troubles, he subsisted for years on a small, thin, well-done piece of steak with nothing else; in later years he felt the cold increasingly, and seemed rarely to emerge from a great shaggy woollen overcoat which only served to enhance a vivid personality.

Fairgrieve neither under-estimated nor scorned the different ways of achieving reform. He knew that one may preach reform in the teaching of a subject for years without result: put one question in a public examination paper of a new type and teachers will adapt their courses overnight. Give the teacher the text-books with the new view and reform is assured. So he did an immense amount of examining and wrote many text-books. Most of the latter were in conjunction with Ernest Young—a short, rotund, insatiable traveller and *bon viveur*. Especially through the six books for the primary school and the three books for the secondary which formed the set of Fairgrieve and Young's "Human Geographies" (which have passed through innumerable editions), geography became something quite different in British schools. Critics to-day may say that the pendulum swung too far: in stressing the human aspects the essential physical basis and logical approach tended to be lost; but this was never intended by Fairgrieve himself. He believed firmly in personal observation for himself and the youngest school child alike, and so developed his interest in local and regional surveys and in microclimatology.

The film was hailed as a powerful new instrument in education, and it was natural to find Fairgrieve not only president of the Geographical Association

(1935), and vice-president of the Royal Meteorological Society (1932–33), but also original member of the Commission on Cultural and Educational Films. His sphere of interest widened when during 1927–35 he held the post of head of the Department of Colonial Education concurrently with his lectureship (readership from 1931) at the Institute of Education. Although he retired under the age limit in 1935, he never retired from active geographical work. As a result of an unfortunate accident he was temporarily crippled, and if he cursed mildly at the inconvenience of a wheel chair it did not deter him from attendance at the executive meetings of the Geographical Association to the very last, nor did his genius for helpful friendship ever leave him. *O si sic omnes!*

L. Dudley Stamp

NEWS and VIEWS

Royal Society: Medal Awards

The following awards of medals have been made by the president and the Council of the Royal Society: *Copley Medal* to Prof. A. J. Kluyver, For.Mem.R.S., for his distinguished contributions of a fundamental character to the science of microbiology; *Davy Medal* to Sir John Lennard-Jones, K.B.E., F.R.S., for his distinguished work on the applications of quantum mechanics to the theory of valency and to the analysis of the intimate structure of chemical compounds; *Hughes Medal* to Sir Edward Bullard, F.R.S., for his important contributions to the development, both theoretical and experimental, of the physics of the earth.

Nobel Prize for Chemistry for 1953: Prof. H. Staudinger

The chemistry of macromolecules has become so commonplace and so well defined that it is difficult to realize how hard the pioneers had to work to convince their scientific colleagues that macromolecules existed at all. The award of the Nobel Prize for Chemistry to Prof. Herman Staudinger sets a seal on this achievement. He was one of the pioneers of the subject long before it became of popular appeal. Many of the basic ideas about macromolecules were beginning to be accepted about the mid-thirties, but for many years before this date Staudinger was one of the very few who showed, by the use of the classical methods of organic chemistry, that small molecules form polymers not simply by a physical process of aggregation but by real chemical interaction. He demonstrated that linear molecules could be built up synthetically in this way by a variety of processes and, what is more, maintain their individuality even though they are subject to chemical modification. Again by classical methods he showed how it was possible to build up high-polymer net-works, and that such net-works would only expand to a finite extent if immersed in suitable solvents. One of his best known contributions is the establishment of the relationship between the viscosity of a solution of a high polymer and its molecular weight. The utilization of this relation permitted, by extrapolation, the estimation of molecular weights of high polymers in molecular-weight regions where no other method was at that time available. Although the relationship has been modified as more knowledge became available about these matters, viscosity methods are, without doubt, the most extensively used as a convenient and simple means of obtaining information about molecular weights of very many polymers. Nobel Prizes are often awarded for an outstanding discovery that ultimately has wide ramifications: with Prof. Staudinger it is the reward for a life-time of effort in a field that has only comparatively recently been accepted as a growing and important branch of both physical and biological science.

Engineering at University College, Dundee: Prof. J. Dick

Dr. J. Dick, who has been appointed to the chair of engineering and drawing in University College, Dundee (University of St. Andrews), as from April 1, 1954, graduated from the University of Glasgow with first-class honours in electrical and mechanical engineering in 1930. He worked in industry with the Albion Motor Car Co. before joining the late Prof. F. C. Lea at the University of Sheffield as a research assistant. A few years later he became a member of the mechanical engineering lecturing staff at that University, and in 1933 received the degree of Ph.D. Later he was appointed to his present post, the Donald Pollock readership in engineering science in the University of Oxford. Though his interests have been concerned mainly with mechanical engineering, they cover a wide range of subjects. He has been concerned with investigations on stresses in wire drawing, the fatigue of engineering materials, mechanical vibrations and lubrication, and has worked on boundary layers and heat transfer in fluid flow. He has published papers on most of these subjects. Prof. Dick is a member of the Institution of Mechanical Engineers, and has taken an active interest in the affairs of the Institution, having acted as honorary secretary of the Yorkshire Branch for five and a half years during the period 1940–45. In taking up the chair at Dundee, Prof. Dick is returning to his own part of the country, as he is a native of Fife.

Work on Guided Missiles at Woomera

In the House of Commons on October 27, in reply to a question regarding his recent visit to Woomera in connexion with the guided rocket programme, and his discussions with the Australian Government, the Minister of Supply, Mr. Duncan Sandys, stated that it had been agreed that the United Kingdom Government should, in future, bear the cost of any further work of this kind which might be done in Australia to its order. The Australian Government has agreed to take over a larger financial responsibility for range equipment ordered by it in the United Kingdom. Apart from basic research, which is not tied to a particular weapon and which goes on continuously, there are three main phases in the development of guided missiles. The first is the design and construction of prototypes; the second, the carrying out of trials and the introduction of modifications indicated to be necessary; and thirdly, there is the manufacturing phase, in which the aircraft or rocket goes into quantity production. It is in the trials stage, said Mr. Sandys, that the vast and well-equipped Woomera range is of such

immense value. Both Governments are agreed that this important defence project should continue to be treated as a joint enterprise.

Use of Atomic Energy in Britain for Electrical Power

In a debate in the House of Commons on the fuel and power industries, held on October 26, the Minister of Fuel and Power, Mr. Geoffrey Lloyd, indicated that we are likely to get useful quantities of electricity from the new nuclear establishment at Calder Hall in Cumberland, and also from the new breeder reactor. It is expected that about 50,000 kW. would be generated as the result of these nuclear activities, and they would provide the data on which future atomic generating stations would be based. Mr. Lloyd stated that there is no reason why atomic power stations should not before long make a useful addition to power resources in Britain. In reply to a further question to the Minister of Supply on October 27, regarding scientific advances during the past two years in using nuclear energy for industrial, domestic, transport and other peaceful purposes, Mr. A. R. W. Low, Parliamentary Secretary to the Ministry of Supply, stated that design studies on a nuclear-power station, using natural uranium as a fuel, have been completed, and an experimental power station of this type is being constructed at Calder Hall. A low-power breeder reactor is nearing completion at Harwell. Design studies are being carried out on a higher-powered reactor of this type, and are also proceeding on other types of reactors which might be suitable for development of power. The application of radioactive isotopes to industrial, medical and research purposes continues to extend, and plans are being made to increase the facilities for their production.

Pest Infestation Laboratory: New Biochemistry Building

A new building for biochemical research at the Pest Infestation Laboratory, Department of Scientific and Industrial Research, Slough, Bucks, was opened by Sir Ben Lockspeiser, in the presence of Mr. G. V. B. Herford (director of the Laboratory) and members of the Pest Infestation Research Board, on November 6. Biochemistry at this Laboratory includes studies on mechanisms of insecticidal action, and on the contamination of stored food products by insecticides and fumigants. Much of the work has been characterized by the extensive use and development of radioactive tracer techniques. The building is of single-story construction and consists of ten laboratories, cloak rooms and boiler room. Two principal end laboratories provide for 'semi-hot' radiochemical and radiobiological work. Each of these contains a three-unit high-efficiency fume chamber provided with stainless steel tray working areas. Other features include two insulated temperature-controlled rooms ventilated with dust-free air for radiometric and enzyme assay respectively. Service points are mounted clear of all working bench surfaces, and have front bench panel controls. Sink wastes run directly to two external drains provided with inspection covers throughout their lengths and a delay tank for monitoring and decontamination. Mr. F. P. W. Winteringham (officer-in-charge of biochemistry in the Laboratory) was responsible for the basic lay-out of laboratories and services. Throughout planning and construction there was a close and successful co-operation between the scientific personnel and Ministry of Works architects concerned (Messrs. R. J. Sneller and A. F. J. Hannaford).

Anglo-Italian Mixed Commission

The Anglo-Italian Mixed Commission of ten members established under Article XII of the Cultural Convention, recently ratified by the British and Italian Parliaments, held its first series of meetings in London from October 26 onwards, under the chairmanship of Sir Ronald Adam. The other members of the British section were Prof. E. R. P. Vincent, professor of Italian in the University of Cambridge; Prof. J. Read, professor of chemistry in the University of St. Andrews; Mr. D. C. Riddy, Ministry of Education; and Mr. K. R. Johnstone, British Council. Lord Crawford and Balcarres, who is also a member of the Commission, was unable to be present. The Italian section was led by Signor Bartolomeo Migone, director-general of cultural relations in the Italian Ministry of Foreign Affairs. Cultural relations between Italy and Britain were firmly established before the signing of the Cultural Convention, the declared object of which is to give the fullest possible support to exchanges covering the intellectual, artistic, scientific, technical and educational activities of each country. At its first series of meetings in London, the Commission reviewed the terms of the Convention in detail and examined projects for future development. The next series of meetings of the full Mixed Commission will be held in Rome. The British Council is designated by the British Government as their principal agent for the execution of the measures falling within the scope of the Convention.

Reclamation of Deserts

A recent issue of *Trees* (**17**, No. 2; 1953) includes several articles on the important question of the spread of aridity, notably in the tropical and subtropical regions, with accounts of current work for its prevention or reduction and the reclamation of affected areas in the U.S.S.R., China and elsewhere. Under the title of "The Recovery of the Sahara", R. St. Barbe Baker refers to his personal experiences of the problems involved and the part he would like to see taken by the society he started some years ago under the name "The Men of the Trees". While some of the proposals, such as "carrying out surveys, studies and pilot schemes", and "fostering a centre for education and research in the forestry aspects of reclaiming the bad lands", are far beyond the capacity of the society, if indeed appropriate to it, any constructive action helping to direct public attention to the urgent need for realization of the dangers of the situation and to stimulate appropriate action is worthy of support. It is, however, important to avoid representing as proved, or at least commonly accepted beliefs, what are actually little more than unsubstantiated opinions or subjective impressions; several examples of infringement of this principle could be selected from the article quoted.

American Association for the Advancement of Science: Meeting in Boston

The one hundred and twentieth meeting of the American Association for the Advancement of Science will be held in Boston, Mass., during December 26–31, under the presidency of Dr. E. U. Condon, director of research, Corning Glass Works,

and director during 1945–51 of the U.S. National Bureau of Standards. The Association is a non-profit organization with four aims—to further the work of scientists, to facilitate co-operation among scientists, to make science more effective in promoting human welfare, and to increase public understanding of science—and the theme this year will be "Scientific Resources for Freedom". For the most part the meeting will be divided into sessions arranged by the Sections of the Association, which are as follows: (*A*) mathematics; (*B*) physics; (*C*) chemistry; (*D*) astronomy; (*E*) geology and geography; (*F*) zoological sciences; (*G*) botanical sciences; (*H*) anthropology; (*I*) psychology; (*K*) social and economic sciences; (*L*) history and philosophy of science; (*M*) engineering; (*N*) medical sciences (with sub-sections (*Nm*) medicine, (*Nd*) dentistry and (*Np*) pharmacy); (*O*) agriculture; (*P*) industrial science; and (*Q*) education. The Association has 48,500 individual members, and with it are associated or affiliated 245 societies, the aggregate membership of which exceeds a million. There will be approximately three hundred sessions, made up principally of some 1,800 short papers; the Sections of the Association are sponsoring about forty symposia, and the participating societies are arranging ten symposia. In addition, the Association is holding two general symposia, on "Species which Feed Mankind" and "The Sea Frontier", respectively. During the special evening sessions at the meeting the following addresses will be delivered: December 27, "The Design and Mechanism of Muscle", by Prof. A. V. Hill, past president of the British Association for the Advancement of Science, and "Sicily, the Forgotten Island", by Luis Marden, staff member of the National Geographic Society; December 28, the presidential address of the retiring president of the American Association, by Dr. Detlev W. Bronk, president of the National Academy of Sciences; and December 30, "Science and Social Conservatism", by Dr. Leonard Carmichael, secretary of the Smithsonian Institution. Further information on the public meeting can be obtained from the acting administrative secretary, Dr. Raymond L. Taylor, A.A.A.S., 1515 Massachusetts Avenue, N.W., Washington, D.C.

University of Leeds

THE University of Leeds has conferred the title of emeritus professor upon the following on their retirement from their respective chairs: Prof. F. Challenger (organic chemistry); Prof. N. M. Comber (agricultural chemistry); Prof. R. D. Passey (experimental pathology); and Prof. A. V. Williamson (geography). The following appointments have been made in the University: F. A. Leeming, lecturer in the Department of Geography; P. H. Broadhurst, lecturer in the Department of Mining; A. Grounds and L. W. Needham, honorary lecturers in mineral dressing and coal preparation; and J. McFarlane, Hugh Wood Memorial Fellow in the Department of Mining. Donations have been made to the University as follows: renewal by the Worshipful Company of Clothworkers for a further seven years from January 1, 1954, of three grants—£3,000 a year special maintenance grant, £3,000 a year research grant, and £500 a year Dyeing Department research grant—for the Clothworkers' Department; £350 from the British Dyewood Co., Ltd., Glasgow, for postgraduate research in the Department of Colour Chemistry and Dyeing; £600 for 1953–54 from the Medical Research Council for the maintenance of a research worker and the expenses of research in microbiological chemistry in the Department of Biochemistry; £500 for 1953–54 from May and Baker, Ltd., Dagenham, for research in the Department of Pharmacology; £8,455 over three years, allotted through the Board of Trade as a Conditional Aid Project (United States), for research on the wool textile industry, to be conducted in the Department of Economics under the direction of Prof. A. J. Brown; a total of £4,400 for the current session from the National Coal Board, made up principally of grants of £600, £250 and £550, to the Department of Mining for special researches, and £3,000 to the University, this latter being the sessional instalment of a grant promised in 1952 for six years.

Announcements

H.M. THE QUEEN has appointed Lord Cherwell to be a Companion of Honour, on his relinquishing the post of Paymaster-General; Lord Cherwell is returning to his post as professor of experimental philosophy in the University of Oxford, but will continue to be available to the Prime Minister and to the Government on atomic energy questions and other scientific matters.

DR. O. W. RICHARDS, Reader in Entomology in the Imperial College of Science and Technology, London, has been appointed to the University chair of zoology and applied entomology tenable at that College in succession to Prof. J. W. Munro, who is retiring.

THE eighth Dalton Lecture of the Royal Institute of Chemistry will be delivered by Sir John Cockcroft at the Manchester Town Hall on November 27 at 7 p.m., his subject being "The Development of Radiochemistry and Radiation Chemistry". Admittance will be by ticket only. In connexion with the Lecture an exhibition on the measurement, use and application of radioactive substances will be held in the Gas Showrooms (Basement) of the Manchester Town Hall on November 26 (10 a.m.–8 p.m.) and 27 (10 a.m.–9 p.m.). Admission to the exhibition will be free and without ticket. Further details of these events can be obtained from A. Ormrod, Hardman and Holden, Ltd., Manox House, Manchester 10.

SIR GEORGE BEILBY Memorial Awards, which are considered by administrators representing the Royal Institute of Chemistry, the Society of Chemical Industry and the Institute of Metals, are made to British scientific research workers, preference being given to investigations relating to the special interests of Sir George Beilby, including problems connected with fuel economy, chemical engineering and metallurgy. In general, the awards are granted to younger workers for original investigations done over a period of years. Awards may be made early next year, and the administrators request that their attention be directed, not later than December 31, to outstanding work of the nature indicated. All communications should be addressed to the Convener of the Administrators, Sir George Beilby Memorial Fund, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1.

ERRATUM. In the article entitled "Magnetic Properties of the Earth's Interior", in *Nature* of October 31, p. 786, Dr. F. J. Lowes is referred to as being of the University of Liverpool; he is a member of the Department of Geodesy and Geophysics, University of Cambridge.

SUPERCONDUCTIVITY

THE Low Temperature Group of the Physical Society was formed shortly after the Second World War, and since then it has regularly held meetings and discussions on topics of interest to users of low-temperature techniques, both industrial and academic. On October 8 a meeting was held in the Science Museum, London, at which four speakers from different universities presented papers concerned with the problem of superconductivity. Prof. D. M. Newitt was in the chair.

Dr. A. B. Pippard (Cambridge) gave a short account of some of the aims of the current work in the Royal Society Mond Laboratory, Cambridge. The multiplicity of mutually exclusive theories which have been advanced to explain the fundamental mechanism of superconductivity is in his opinion evidence that there is not nearly enough known of the experimental behaviour of superconductors, particularly as regards the finer details of their behaviour. One of the aims of the experimenter should be to construct a physical model of superconductivity which should provide a unified account of the various aspects of the phenomenon and as definite as possible a picture of what must be given a fundamental explanation in terms of the electronic structure of metals. Two important contributions to this end are the theory of F. and H. London of the relation between current and magnetic field, and the two-fluid model of Gorter and Casimir. The former accounts for the almost perfect diamagnetism of a superconductor (Meissner effect), and implies exponential penetration of field to a small depth; the latter correlates the thermodynamic properties with the temperature variation of the depth of penetration. More searching tests of these ideas are now being undertaken. The thermal conductivity and the resistance at very high frequencies both yield information concerning the normal electrons, and the present position seems to be that although the two-fluid model provides a rough explanation of the observations, there is room for improvement, especially as regards the high-frequency resistance. Measurements on thin films and colloidal particles in principle enable the London theory to be tested, but as yet, owing to the extreme delicacy of the experiments, no definite evidence has been obtained. On the other hand, measurements of the absolute magnitude of the penetration depth and of its variation when small amounts of impurity are present suggest that the London theory may be improved by bringing into it the mean free path of the electrons or an analogous parameter. Support for this view comes from studies of the surface energy between normal and superconducting phases, which has been found to be dependent on the mean free path. It is hoped that further work on these lines will eventually permit a better understanding of the nature of the supercurrent and of superconductors in general.

The other speakers discussed more specific topics with which they have been recently concerned. Mr. H. Teague (Bristol) gave an account of the properties of the so-called 'hard' superconductors—vanadium, tantalum and niobium—which are typical of superconductors belonging to Groups 4 and 5 of the Periodic Table. In contrast to tin and other 'soft' superconductors, these have rather broad transitions and the Meissner effect is often very imperfect. There is also a marked tendency for the destruction of diamagnetism to occur at a lower magnetic field-strength than is required to restore resistance. These effects are likely to be caused by inhomogeneities produced either by mechanical working or by interstitial impurity atoms. The former may be removed by prolonged annealing *in vacuo* at a very high temperature, but this rarely removes dissolved impurities; indeed, if the vacuum is not good, additional gaseous impurities may go into solution. Wexler and Corak have demonstrated the deterioration in the behaviour of vanadium resulting from interstitial impurities, while Webber finds no such effect in tantalum. It is therefore likely that, in the latter, mechanical strains are the more important influence. The improvement which vacuum annealing produces in niobium has been studied at Bristol, and the observations support the view that both causes of inhomogeneity are important. It has also been found that some samples after annealing behave very strangely: the resistance drops fairly sharply at the transition temperature for niobium, but not to zero, and the drop is less after more prolonged annealing. It seems likely that individual grains become superconducting but the grain boundaries, which are observed to be broadened by annealing, do not. During the discussion Dr. K. Mendelssohn (Oxford) suggested that the grain boundaries might act as nuclei for the growth of a different crystalline modification which is not a superconductor.

Mr. C. A. Renton (Oxford) discussed the thermal conductivity of superconductors, particularly in the temperature-range below 1° K. According to the two-fluid model of Gorter and Casimir the superconducting electrons have no entropy, and are unable, therefore, to contribute to the conduction of heat, which is effected by the normal electrons and by elastic waves in the ionic lattice. If the scattering of electrons by the lattice is predominantly due to impurities rather than thermal oscillations, the temperature dependence of the electronic contribution is found to agree well with Heisenberg's theory at temperatures not too far below the transition temperature. At lower temperatures Koppe's refinement of the theory appears to be substantiated, and the electronic contribution tends to vanish more rapidly than is predicted by Heisenberg's treatment. At the same time, according to a hypothesis of Hulm, the lattice contribution should increase with lowering of the temperature, since only the normal electrons may be expected to be capable of interacting with the lattice and scattering lattice waves. This expectation is confirmed by the observation that at the lowest temperatures the conductivity in lead, tin and indium varies as T^3, the expected variation for lattice conductivity. The mean free path of the lattice waves is found under these conditions to be of the order of the diameter of the specimen, so that apparently only boundary scattering of lattice waves is effective. In tantalum, on the other hand, the thermal conductivity below 1° K. varies as T^2, which may be accounted for by the hypothesis that there remains even at 0° K. a residuum of normal electrons, insufficient to contribute noticeably to the conductivity, but adequate to scatter lattice waves.

Measurements have also been made on the thermal conductivity in the intermediate state, which may be considerably less than in either of the pure superconducting or normal states; the effect is observed in both longitudinal and transverse fields, and indicates additional scattering processes at the phase boundaries. In the course of the discussion it was mentioned that Laredo at Cambridge has obtained by experiments on impure tin powerful support for the view that lattice conductivity is dominant at the lowest temperatures.

Finally, Prof. G. O. Jones (Queen Mary College, London) described work carried out under his direction by Mr. P. F. Chester on superconductivity at high pressures. The transition temperature is affected by volume changes, and a study of the magnitude of the effect is of interest in connexion with fundamental theories, as those of Fröhlich and Bardeen. By means of Bridgman's crossed knife-edge technique, modified for use at helium temperatures, pressures up to 40,000 atmospheres may be applied to small specimens, the transition of which to superconductivity is observed magnetically. The transition temperature of tin is reduced to about 3° K. from 3·73° K. by the application of 17,000 atmospheres; and although the transition is not very sharp at the high pressure, it is sharp enough to demonstrate that over the majority of the specimen the pressure is nearly constant. So far as the experiments go, there is no evidence for any change in slope of the critical-field curve under pressure. In thallium, contrary to a report by Russian workers, at lower pressures the transition temperature is also reduced by pressure, but only by about one-tenth of the amount found in tin. Of considerable interest is bismuth, for a long time believed to be on the verge of being a superconductor. Hilsch found that bismuth films deposited at 4° K. were superconducting, and it now turns out that massive bismuth is superconducting at pressures greater than 20,000 atmospheres, the transition temperature, 7° K., being nearly constant up to 41,000 atmospheres. Removal of the pressure destroys superconductivity. Since there is a phase-transition in bismuth at room temperature to a more close-packed structure at about 25,000 atmospheres, it seems natural to suppose that it is this modification which becomes superconducting. Other metals being studied are calcium and strontium, which according to Fröhlich's criterion might be expected to become superconducting, but this is not observed up to 40,000 atmospheres. A. B. Pippard

EMPIRICAL RESEARCH IN INDUSTRY

WIDELY varying methods of research for studying the behaviour of individuals and organizations in industry were discussed at an informal week-end gathering held in York during October 2–5 under the auspices of the Acton Society Trust and the York Civic Trust. With backgrounds in the disciplines of anthropology, psychology, sociology, industrial relations, industrial and public administration, operational research, and engineering, twenty-three persons from nineteen university and other research groups met with the common bond that all are actively concerned with research studies of industry.

Two full days of informal discussion were prefaced by a reception, held in the ancient St. Anthony's Hall which now forms part of the Borthwick Institute of Historical Research. The conference was welcomed to York by the chairman of the York Civic Trust, Dr. J. B. Morrell, the chairman of the Acton Society Trust, Prof. A. W. Harvey, and the Lord Mayor of York. On behalf of the visitors, Mr. R. G. Stansfield (Department of Scientific and Industrial Research) said that many research workers, in different parts of Great Britain and working in very different ways, are studying what may be called "the natural history of industry"; often these workers are not well aware of the methods, problems and interests—and sometimes even of the existence—of other workers on related problems. The object of the meeting was to bring together some of these people, so that they could get to know each other and stimulate each other's ideas, with plenty of time for free and frank discussion. York, with its tradition of social pioneering, associated with such names as Seebohm Rowntree and William Temple, was a fitting place for such a conference; and especially in view of Rowntree's pioneer empirical studies of poverty in York, and his association with the early days of the Industrial Health Research Board.

On October 3, Mr. Tom Burns (Edinburgh University Social Science Research Centre) spoke of his research into factory organization. He stated that we are largely at the stage of crude ignorance of what management does; he himself had used the Carlson technique to record how managers spend their time. His findings suggest that in some organizations it would be wrong to talk in terms of vertical communication; the flow of communication is much more 'lateral' than top management usually thinks, and vertical communication is better thought of as 'controlled leaks' up and down from the lateral system. Mr. R. Denerley (Medical Research Council Industrial Psychology Research Group) mentioned six investigations by the Group now under way. The methods used are those of general observation, analysis of factory records, and interviewing techniques; he described some of the work done on investigating and validating various interview techniques. Discussion of these papers took up the second session.

In each subsequent session discussion was prefaced by a single, short paper. Mr. H. Clegg (Fellow of Nuffield College, Oxford) described his methods, as a student of industrial relations, in the study of large-scale organizations. Mr. J. R. Gass (Department of Scientific and Industrial Research), analysing broadly research problems and methods, pointed out that the three previous papers described the use of very different interviewing methods. Each method is appropriate in its own place; his criticism was that the users are unwilling to state the limitations of their method. If between the 'human relations' and 'industrial relations' schools a conflict—a false conflict—seems to be replacing mutual indifference, it is a sign of the impact of mutual relevance of the two approaches. At present, each can be criticized for what it ignores; much American sociology on the changing of habits ignores economic forces and the effect of large-scale organizations external to the factory; the industrial relations school, which studies these large-scale organizations, is interested in the conflicts of power, but tends to ignore the informal structure and personal forces. The link between the two approaches may be found in the

study of the conflict for internal power in large-scale organizations.

In a joint contribution, Dr. Alastair Heron and Dr. P. H. Venables (Medical Research Council Unit for Research in Occupational Adaptation) described an investigation of the relation between psychological handicap and occupational adjustment. In this study, the third of a series, relatively objective techniques have been used both in the assessment of psychological handicap and in the evaluation of job-satisfaction and value to the employer. A particular feature of this inquiry was the use of various techniques within the same interview, to indicate the degree of consistency of the data obtained. Mr. Gussmann spoke of the Acton Society Trust's interest in large-scale organizations; this comes under the headings of the internal administrative problems, problems of public control, and problems of the effect on the individual in the organization. From an anthropological background, he is studying five gas-works, of very different sizes, in one particular area, to find out the effects of size of the works. Preliminary results suggest that systematic differences in indices, such as absenteeism, may be due not directly to sheer size but to 'black spots' being harder to control in a larger organization; or to apparently identical jobs in two organizations being inherently different because one organization is big and the other small.

Mr. R. N. Spann (Department of Government and Administration, University of Manchester) discussed the place of the case-study in research and teaching. Case-studies, he pointed out, are so various that the term is of little meaning; they differ enormously in detail of reporting, and whether the description is purely that of a contemporary observer or includes extensive interpretation. By contrast with the abundance of material about how politicians behave, there is a great lack of material about business administration. The most valuable narratives are by people who do not rationalize too much; some accounts of organizations, blinkered by adherence to 'principles of organization', become less and less revealing.

At the final session, Mr. R. G. Stansfield, who acted as chairman during the discussion sessions, summed up the conference. The people for such a conference could not have been found even five years ago; and another sign of the growth and integration of the social sciences in the study of what goes on in industry was the standard of the discussion and constructiveness of the criticism. Thanks were due to Dr. T. E. Chester, of the Acton Society Trust, and his staff for organizing the conference.

In retrospect, the conference seems to have met a real need in bringing together people who did not know of each other's work or—in some cases—each other's existence. It was suggested that social scientists spend much less time than do physical scientists in correspondence between research workers for the exchange of news and views; and those present expressed the future intention of mending their ways. Another live subject linked the scientific method and the problem of recording the results of research. It appeared to emerge that much of the controversy among social scientists about the scientific method (usually in terms of the believed practices of the physical sciences) is misconceived in terms of quantitative and other techniques; the real distinction is between scholars' attitudes of mind, scientific, philosophical, historical and so on. It was suggested that the essential element in the scientific attitude is a distinctive sense of responsibility; including responsibility for seeking out all the relevant data, and for striving to take into consideration all possible alternative interpretations and theories. Especially, the researcher is responsible, in reporting his work, for ensuring that all necessary key details of situation, methods and observations are put on record to enable future workers to compare their results with his and to evaluate his conclusions. In this connexion it was recognized that in accepting this responsibility, the research worker must depend on an equally responsible attitude in the editors of scientific journals.

The interview is the research tool which, in one form or another, is used in all the researches which were described; but while some users appear to take this tool more or less for granted, others are intensely concerned with its techniques and conditions, and it would seem that a whole conference might usefully be devoted to considering knowledge about the interview and its use in the different disciplines of study. Last, but not least, was the sense which kept breaking into the discussion, that the studies which were described, of worker or management behaviour, or of industrial relations, were but stages towards the goal of study of the firm, of the organization, as a going entity; but this study remains for the future to grasp.

R. G. Stansfield

TEACHING OF MECHANICS IN BRITISH UNIVERSITIES

During September a series of informal discussions was held at the Department of Engineering of the University of Cambridge, under the auspices of Prof. J. F. Baker, to consider "the teaching of mechanics, vibrations and control". Representatives were invited from the departments of mechanical engineering of all universities and colleges of university standing in the United Kingdom; in very many cases the head of the department himself elected to attend, so that the fifty or so members of the symposium, as it was called, included a remarkably wide range of engineering teaching experience at this level. A few visitors from large industrial concerns were also invited, to represent the user's point of view.

The nine discussion-periods of an hour and a half each extended from "How much mechanics ought every engineer to know?", through the scope of courses at various levels, to the consideration of teaching techniques, laboratory work and the approach abroad. Each discussion was introduced by a speaker who suggested, as provocatively as he might wish, particular points on which he believed an exchange of views might be valuable. Prof. W. J. Duncan, for example, in opening the discussion of advanced teaching techniques, put in a plea for wider use of the concept of mechanical admittance; and Prof. W. A. Tuplin, of the postgraduate school of applied mechanics in the University of Sheffield, in introducing the subject of advanced and post-graduate courses, wittily described some experiences at this school.

A meeting such as this, which would be a mere commonplace in the United States, is something of an innovation in Britain, and it was most encouraging

to find just the same willingness here to admit that there is room for experiment and improvement in many directions. This attitude is particularly important in the branch of engineering under discussion, which has been taught longer than any other and is thus the most likely to lead its teachers to become static and unimaginative or, even worse, complacent about the present methods and courses.

The visiting members of the symposium lived and dined together in Pembroke College, and more than one formal social gathering was arranged during the three days.

It is hoped that the lead given by the organization of this symposium may persuade those in other fields to initiate similar informal meetings, for it was the universal opinion of those attending that the discussions and the personal contacts were both enjoyable and valuable. R. H. MACMILLAN

FOREST DEPARTMENT OF TRINIDAD AND TOBAGO

REPORT FOR 1951

THERE has been a steady progress in forest conservancy in Trinidad and Tobago, as is well revealed in the annual report for the year 1951*. The mora forests covering a large area, to which constant allusion was made in reports of a score of years or so ago, are now under conservative exploitation with plans of working coming into force. Reservation of forests is approaching completion; the total area of Crown forests is said to be 617,921 acres, and this is about 50 per cent of the area of the Colony, which has an average length of 50 miles, breadth of 37 miles and a total area of 1,862 square miles. The figures for Tobago are 26 miles by 7½ miles at the widest part and a total area of 116 square miles.

A regulation of the saw-mills in the Colony and the introduction of better equipment to reduce the great waste in conversion were undertaken during the year. Interesting sylvicultural work in connexion with natural regeneration is being undertaken, and an extension of the annual teak-planting area has been sanctioned. The areas under the Forest Department are divided into the Northern and the Southern Divisions. In the latter is the largest forest in the region, the 'Trinity Hills Forest', now to be named "Victoria–Mayaro Reserve", of 129,977 acres. The assistant conservator of forests is in charge of the division, assisted by a forest supervision ranger and forest guards. There is an excellent road system in Trinidad and a ten-year programme for feeder forest roads has been sanctioned, some of these latter to connect with some of the fine new roads of the oil company. Housing for the staff is making progress, and some excellent examples of wooden cottages for forest guards have attracted considerable attention. Climbing plants are giving trouble in the teak plantations, an inevitable pest in tropical forests. Shifting cultivation, with its resultant erosion, and the problem of the squatters in government forests are far from settled, but attempts were being made to settle them in village gardens and also to develop a teak *toungya* scheme. The research branch was renewed in January 1951.

Private forestry is not new in Trinidad, for mahogany plantations were made during 1905–6 by private owners in the hills of the Northern Range, and they now contain trees of timber size with prolific regeneration beneath, which has ousted all other growth. The protection of local fauna has made considerable progress, and there is a small Game Department under the conservator of forests, with wardens. In addition, all forest officers are *ex officio* game wardens, and there are fifty-three honorary game wardens selected from the keen hunters, naturalists and estate owners in the Colony. As is common with some native populations, it is very difficult to enforce a close season, and in this connexion some amendments to the former laws are to be introduced. The revenue from the Department is increasing from sums received from game licences and so forth, and grants from these funds are to be made to the Zoological Society, when this has been incorporated, and to finance a zoo at the Botanical Gardens.

* Forest Department, Trinidad and Tobago. Annual Administrative Report of the Conservator of Forests for the Year 1951. Pp. 28. (Trinidad, B.W.I.: Govt. Printing Office, 1952.) 48 cents.

NUFFIELD FOUNDATION

REPORT FOR THE YEAR 1952–53

THE eighth report of the Nuffield Foundation covers the year ending March 31, 1953*, the fourth of the Foundation's second quinquennial programme, in which allocations against the year's income reached the record total of £713,696. Of this, £319,296 was for research in the United Kingdom—£155,686 for biological research, £54,460 for sociological studies and £109,150 for other scientific work. £26,400 was allocated for research in the British Commonwealth overseas and £36,000 for fellowships and scholarships, and £250,000 for the next five years was promised to the National Corporation for Old People. Under the programme for research on ageing, £25,000 was reserved for a Nuffield gerontological research fellowship, while from the Oliver Bird Fund for rheumatism grants amounting to £24,760 are to be met from the year's income and £18,626 from future income.

Three new grants from the Foundation's uncommitted resources or 'Free Fund' are all in the field of physics: these are to the Department of Mineralogy and Petrology and the Cavendish Laboratory, Cambridge, for a joint study of phase-relations and atomic structure of the feldspar group of minerals; to the Department of Physics of the Royal Cancer Hospital, University of London, for work on the application of physics to diagnostic problems; and a further £20,000 over five years for the appointment of further Nuffield Fellows to Lord Cherwell's low-temperature research group at the Clarendon Laboratory, Oxford. The Foundation has also purchased for £50,000 some special material for research, and £30,000 was allocated to complete the £200,000 promised for the radio-telescope at the University of Manchester.

Of the twenty-six new grants for biological research, seven were for immunological research and six for biophysical and biochemical research, three being in

* Nuffield Foundation: Report for the Year ended 31 March 1953 (Eighth Report). Pp. 109. (London: Nuffield Foundation 1953.)

botany. Botany departments are also being assisted in research using micro-organisms, and assistance is being given in comparative endocrinology in the hope that study of the glands of simpler animals may throw light on hormones in the human. The larger grants include £5,250 a year for three years to the Molteno Institute of Biology and Parasitology, Cambridge, for the continuation of Prof. D. Keilin's work on respiratory enzymes; £3,000 a year for five years to the Lister Institute of Preventive Medicine, London, for the study of non-specific defence mechanisms in the early stages of infection; £2,750 a year for five years to the Department of Botany of University College, London, for the establishment of the Nuffield botanic research garden, including research on the physiology of sex in flowering plants; £6,050 for equipment and £1,000 a year for five years to the Department of Biophysics of the College, for work on the permeability of cell membranes and excitable tissues; and a further £10,200 over three years to the Department of Anatomy of the College, for work on the flying-spot microscope and its application to biological research, as well as for the exploration of other electronic techniques. The Research Institute of Plant Physiology, Imperial College of Science and Technology, London, has been promised grants totalling £5,562 over three years towards investigations on the metabolism of the plant polysaccharides and the associated enzyme systems, and £4,294 for its work on gaseous exchanges in leaves and on stomatal mechanism; £8,900 over five years goes to the Department of Experimental Pathology, University of Birmingham, for the immunological study of plant proteins; £8,400 has been provided for the capital and five-year recurrent costs of establishing a radio-carbon dating project in the Sub-Department of Quaternary Research of the Botany School, University of Cambridge; and £2,150 for equipment and £1,300 a year for five years for research in experimental vertebrate embryology in the Anatomy School, University of Cambridge. £6,000 is being provided over five years towards the work on general immunology at the Department of Pathology, University of Cambridge, also supported by the Agricultural Research Council, and £2,000 a year for three years for expansion of the research on the genetics of micro-organisms at the University of Glasgow, while a grant of £1,700 over three years to the Department of Zoology, University of Liverpool, is in support of an investigation of the basic physiology of the endocrine glands in lower vertebrates; £5,600 over three years also goes to the Department of Natural History, University of St. Andrews, for other work in comparative endocrinology, and £5,000 to the Department of Physiology, University of Aberdeen, for work on the bearing of the quantum properties of electromagnetic radiation on the physiology of vision. The Department of Colloid Science, University of Cambridge, has been granted £1,400 for three years for work on the specificity of protein reactions and £800 a year for three years for the investigation of the antigen–antibody reaction by the light-scattering technique, while a personal grant of £3,340 over three years has been made to Prof. J. R. Marrack for his work in the Department of Pathology, University of Cambridge, on antigens and antibodies and the nature of complement and conglutinin. Grants totalling £3,000 over three years for an investigation of the physiology and genetics of sexual reproduction in fungi and of £900 a year for three years for research on the respiratory behaviour of plant tissues have been made to the Department of Botany, University of Oxford.

Grants for sociological studies include £22,500 over the next five years to the National Institute of Economic and Social Research, London, and a further £15,000 to the Population Investigation Committee for the publication of its journal, *Population Studies*, and a programme of research including studies of migration, marriage and fertility, both in Britain and in other Commonwealth countries.

From the Oliver Bird Fund a new grant of £2,000 was made to the Department of Physics applied to Medicine, Middlesex Hospital Medical School, London, for physical apparatus for work on the mineral activity of adrenal corticosteroids. Renewed grants were made to the School of Biochemistry, University of Cambridge, for work on the isolation and purification of the adrenocorticotropic hormone (£4,100); to the Department of Biomolecular Structure, University of Leeds, for its collaboration with the Rheumatism Research Centre, University of Manchester (£1,000); and to the Dyson Perrins Laboratory, University of Oxford, for attempts at the total synthesis of cortisone. The £37,000 allocated for research into practical problems includes £36,000 for establishing a unit for functional research in building design. Miscellaneous grants include £4,000 a year for three years to the Oxford Regional Hospital Board for a study of the relation of physique to mental and nervous disorders, £1,200 towards an expedition to study the blood-groups and search for the sickle-cell trait in the Andaman Islanders, £1,000 a year for three years to the Y.W.C.A. for courses in tropical rural welfare for women from the Commonwealth and under-developed countries visiting Britain, and £1,500 to the Department of Anatomy, Charing Cross Hospital Medical School, London, for a study of the development of the human placenta.

New grants for research overseas within the Commonwealth include £1,200 a year for three years to further the expansion of the work of the Australian and New Zealand Association for the Advancement of Science, £2,000 to the University of Cape Town for the purchase of spectrographic equipment for the Department of Geology, £1,000 to the Transvaal Museum for a mobile entomological laboratory and £12,000 towards the capital cost of the metabolic unit to be established at Kampala by the Medical Research Council and the Government of Uganda for the study of infantile malnutrition and particularly the prevention of kwashiorkor.

During the year fifty-four Nuffield Fellows, Scholars and Bursars (including twenty-seven travelling fellows from the Dominions) were appointed under the Foundation's various schemes. More interest was taken in the dental fellowships and scholarships scheme, while the scheme of travelling scholarships for farmers of the United Kingdom operated very satisfactorily, and the Foundation decided to institute a number of more junior awards, namely, farming bursaries, tenable for one to three months for travel in the United Kingdom and, for a few weeks, in a Scandinavian country. The biological scholarships and bursaries scheme is now interesting a wider and stronger field of applicants. Under the scheme of lectureships and special grants for eminent scientists or scholars, some Canadians and one Australian visited the United Kingdom, and the United Kingdom sent two to Australia, one to South Africa, two to Canada and the United States, and one to Scandinavia.

A NEW PHENOMENON IN TIME JUDGMENT

By Prof JOHN COHEN, C. E. M. HANSEL and J. D. SYLVESTER

Department of Psychology, University of Manchester

THE *tau* effect, demonstrated by Helson and King[1] in 1931, may be illustrated by the following example. If three points are marked off on the observer's skin and the interval of time between stimulating the second and third points is greater than that between the first and second, the observer reports that the distance between the second and third points is greater than that between the first and second, though in fact it may be equal or less. Geldreich[2] has devised an apparatus whereby this effect may be shown to occur with visual stimuli. These phenomena show a dependence of judgments of distances between stimuli on the time intervals separating them. The experiment to be described was designed to test quantitatively the hypothesis that judgments of temporal intervals between visual stimuli are similarly dependent on their spatial relations.

The subject sat in a dark room and observed in front of him a repeated succession of three equal flashes of light set horizontally. Each cycle of three flashes was repeated after an interval of 5/3 of the total cycle. By adjusting a lever he was able to control the timing of the flash of the centre light over a range varying from simultaneous with the first light to simultaneous with the third. That is, if the interval of time between lights 1 and 2 is designated t_1, and that between lights 2 and 3 designated t_2, he adjusted the lever until he judged t_1 as equal to t_2. The distances separating the lights could be varied by the experimenter. The shorter of the two distances remained constant at one foot and the longer distance was varied so as to give a ratio ranging from 1 : 10 to 10 : 1. If the first distance is called d_1 and the second d_2, the ratio d_1/d_2 varied from 1/10 to 10/1. The cycle of lights was repeated continuously until the subject had completed his adjustment, which he indicated by pressing a button.

Subjects made four judgments at each distance ratio : one pair with the shorter distance first, one pair with the longer distance first, one of each pair being presented with the right to left direction reversed.

In the accompanying table we show in columns (i) and (ii) the mean values of t_2/t_1, for each ratio of d_2/d_1, when $T = (t_1 + t_2) = 1{\cdot}4$ sec. In columns (iii) and (iv) the mean values of t_1 and its standard deviation are given respectively. In column (v) we show the values of t_1 corrected for time error. Time errors are effects which occur in judgments involving successive presentations of stimuli. In this case a correction is made by multiplying values of t_1 by a constant derived from the 1 : 1 ratio of distances. Column (vi) gives an estimate of the percentage effect of the phenomenon.

Similar effects were obtained with $T = 0{\cdot}6$ sec. and $T = 6{\cdot}4$ sec. Within this range of T (0·6–6·4) the effect tends to diminish as T increases. The effect is significant at all values so far measured.

It may be seen from column (vi) in this table that comparative judgments of two successive time intervals delimited by successive flashes of light are influenced by the spatial relationships of these flashes. Although the figures given in the table relate to the means for ten subjects, repeated trials with single subjects show that intra-individual variation is less than inter-individual variation. This statement is based on 6–20 trials by different subjects at each distance ratio. The standard deviations for the individual subjects range from 0·022 to 0·067 for different distance ratios when $T = 1{\cdot}4$ sec.

Mean results for 10 subjects when $T = (t_1 + t_2) = 1{\cdot}4$ sec.

(i)	(ii)	(iii)	(iv)	(v)	(vi)
$\frac{d_2}{d_1}$	$\frac{t_2}{t_1}$	t_1 (sec.)	σ_{t_1} (sec.)	t_1' (sec.)	$\frac{t_1'-t_2'}{t_1'} \cdot 100$ (percentage)
1/10	1·15	0·65	0·059	0·66	−12·1
1/8	1·22	0·63	0·058	0·64	−18·8
1/6	1·26	0·62	0·057	0·66	−12·1
1/5	1·22	0·63	0·051	0·65	−15·4
1/4	1·30	0·61	0·071	0·64	−18·7
1/3	1·37	0·59	0·089	0·60	−25·8
1/2	1·19	0·64	0·014	0·67	− 9·0
1/1	1·10	0·67	0·093	0·70	0·0
2/1	0·92	0·73	0·034	0·76	15·8
3/1	0·89	0·74	0·035	0·77	18·2
4/1	0·89	0·74	0·051	0·77	18·2
5/1	0·87	0·75	0·046	0·80	25·0
6/1	0·87	0·75	0·010	0·78	20·5
8/1	0·94	0·72	0·062	0·73	8·2
10/1	0·89	0·74	0·048	0·75	13·3

The effect is such that when the observer is adjusting the time intervals so that they appear equal he makes the time interval between the two flashes spaced farther apart shorter than the time interval between the two flashes closer together. The phenomenon that thus emerges is that when three flashes of light are successively presented and separated by equal temporal intervals, one temporal interval will seem longer as the relative distance between the corresponding flashes increases. We propose to designate this phenomenon as the *kappa* effect to distinguish it from the *tau* effect. A measure of this effect is given in column (vi). When, for example, d_2/d_1 is 1/10 there is a 12 per cent under-estimation of t_1, and when d_2/d_1 is 10/1 there is a 13 per cent over-estimation.

A brief reference may be made to two further conclusions which will be more fully described elsewhere : (*a*) order of presentation ; and (*b*) effect of visual angle. The *kappa* effect is uninfluenced by the order in which the distances are presented. This fact is in conflict with the Gestalt theory of perceptual transposition.

The total visual angle subtended by the display in the experiment reported varies with the distance ratio being measured, since the shorter distance is constant at 1 ft. The decline in the effect at the extreme ratios seems to be due to the increase in visual angle. Experiments in progress show that when the distance ratio is held constant the *kappa* effect increases with decrease in the visual angle.

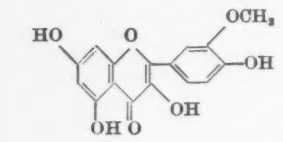
It would seem from the two phenomena that the spatial and temporal components of the space–time events about which judgments are made are psychologically interdependent. It may be asked whether the spatial element as such is an essential feature of this type of temporal phenomenon and whether a delimitation of the time intervals by other kinds of non-spatial stimuli such as auditory pitch might produce similar effects. If so, it would be possible to employ temporal judgments as a probe in the general study of inter-sensory phenomena, a subject which is receiving increasing attention. [Oct. 5.

[1] Helson, H., and King, S. M., *J. Exp. Psychol.*, **14**, 202 (1931).
[2] Geldreich, E. W., *Amer. J. Psychol.*, **46**, 483 (1938).

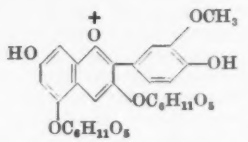
BIOGENESIS OF FLAVONOIDS IN *CHLAMYDOMONAS EUGAMETOS*

By Prof. A. J. BIRCH*, F. W. DONOVAN* and Dr. F. MOEWUS†
University of Sydney

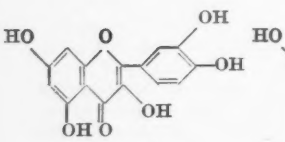
A NUMBER of theories have been advanced to explain the biogenesis of flavonoid and anthocyanin pigments in plants[1,2], the most fundamental of which, due to Robinson, postulates a C_6—C_3—C_6 linkage ultimately due to carbohydrate units. Opinions are very varied on the origins of points of detail in the structures, for example, on how the various states of oxidation are attained and whether flavonoids precede anthocyanins in the chain of biogenesis. Despite much work on the genetics of flower colour[3], little that is conclusive has emerged, except the demonstration that the processes are gene-controlled, and that flavonoids and anthocyanins are derived from the same precursors, if not in sequence. The chief difficulties with this work are the extreme complexity both of the genetic factors and of the pigment mixtures, and in order to provide evidence of much value most of it would need to be repeated using modern chemical techniques.



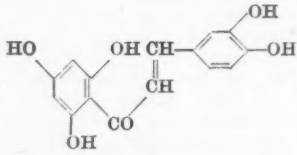
(I)



(II)



(III)



(IV)

A much more amenable organism for biochemical study is found among the lower plants, since the green alga *Chlamydomonas eugametos* uses the flavonoid isorhamnetin (I) and the anthocyanin peonin (II) as sex hormones[4]. Briefly, a dicecious culture transferred from agar to water, if illuminated, undergoes a series of changes, developing flagellæ, motility and ability to copulate. All these stages are hormone-controlled, the hormones required for sex-determination and therefore ultimately for copulation being, for the male peonin, for the female isorhamnetin[4]. During 1939–51 a large number of mutation experiments were carried out, using X-rays, radium, ultra-sound, chemical compounds and temperature shocks. From these were obtained thirty-seven mutants which were genetically female but which were not able to copulate with male gametes. However, they did so on the addition of traces of isorhamnetin. Of these mutants, twenty-six were rendered capable of copulation when given quercetin (III), the remaining eleven reacting only to isorhamnetin. Some sixty other flavonoids tested were without activity. Kuhn and Loew[5] succeeded in isolating quercetin from one of the eleven mutants, and we have further identified the substance from this mutant by the use of paper chromatography; from another female mutant (*irha*$^{+++}$) Kuhn and Loew isolated isorhamnetin. The twenty-six mutants can obviously convert quercetin to isorhamnetin; the other eleven cannot.

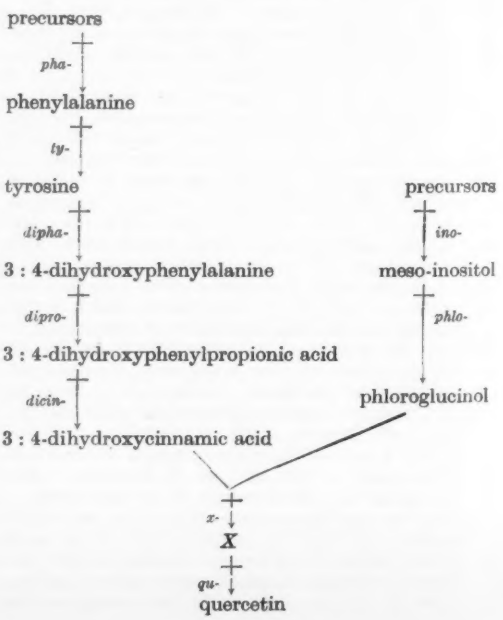
There was at this stage no indication of the number of steps, since many of the mutants from different mutation experiments could be, and were found to be, biochemically identical.

These results can be briefly summarized: precursors (unknown number of stages, twenty-six mutants) → quercetin (III) → isorhamnetin (I) (unknown number of stages, eleven mutants).

Substitution experiments were then carried out with the twenty-six mutants. The mutants were kept in a solution of the substance to be tested (concentration 10^{-5}–10^{-9}) for four hours, and a drop was then mixed with normal male gametes. Immediate copulation is indicated in Table 1 by a (+) sign. This presumably indicates the ability of the mutant to produce quercetin from the test substance. Table 1 shows twenty-five mutants; the twenty-sixth is a double mutant (*dicin*-^{6}–*phlo*-^{9}). The concentration *c* is the lowest limit for observable activity.

Among compounds found to be inactive were: 3- and 4-hydroxycinnamic acid, 4-hydroxy-3-methoxycinnamic acid, *cis*- and *trans*-cinnamic acid, phenylpropionic acid, 3- and 4-hydroxyphenylpyruvic acid, phenylpyruvic acid, phenyllactic acid, 3 : 4-dihydroxybenzoic acid, methylphloroglucinol, phloroacetophenone, epiinositol and pyruvic acid. It is noteworthy that (−)- and (±)-phenylalanine and (+)- and (±)-tyrosine have the same activity to an order of ten, which is the limit of sensitivity of the test.

If we can assume that the substances are active by virtue of their transformation to quercetin, and not *per se*, then the following scheme of biogenesis is indicated:



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† Botany School.

Table 1

qu-Mutants (twenty-five ; arbitrary numbers)	3, 4, 7, 13, 19, 23	2, 10, 16	1, 15, 21, 24	5	12, 20, 22	8, 11, 17	6, 9, 14	18, 25
Quercetin ($c = 10^{-10}$)	+	+	+	+	+	+	+	+
3,4, di.OH Cinnamic ($c = 10^{-8}$)	−	+	+	+	+	+	−	−
3,4, di.OH Propionic ($c = 10^{-7}$)	−	−	+	+	+	+	−	−
3,4, di.OH Phenylalanine ($c = 10^{-7}$)	−	−	−	+	+	+	−	−
Tyrosine (+) and (±) ($c = 10^{-6}$)	−	−	−	−	+	+	−	−
Phenylalanine (−) and (±) ($c = 10^{-5}$)	−	−	−	−	−	+	−	−
Phloroglucinol ($c = 10^{-6}$)	−	−	−	−	−	−	+	+
m-Inositol ($c = 10^{-7}$)	−	−	−	−	−	−	−	+

Neither of the mutants on the phloroglucinol side of *X* is affected by any of the substances on the 3 : 4-dihydroxycinnamic acid side, and vice versa. The nature of *X* is at present unknown ; but the reaction would suggest that it is the chalcone (IV) or the corresponding flavanone or flavone.

If this scheme is correct, then the *dicin*-mutant should accumulate 3 : 4-dihydroxyphenylpropionic acid, the *x*-mutant phloroglucinol and 3 : 4-dihydroxycinnamic acid and so forth. This has several consequences. One is that any pair of mutants on the same branch of the synthetic scheme should be capable of copulation if mixed, since one or other will be capable of supplying a substance required by the other mutant for completion of the quercetin synthesis. In fact, a mixture of the *ino*- and *phlo*-mutants copulated with male gametes, as did all mixtures of *dicin*-, *dipro*-, *dipha*-, *ty*- and *pha*-, but not a mixture of this group with the preceding one. Another consequence is that the accumulated substances would be detectable biologically and chemically, for example, a centrifugate from the *ty*-mutant should contain phenylalanine. The copulation tests on such centrifugates bears this out (Table 2), the solutions from each mutant activating all the preceding ones in the series.

Table 2

Centrifugate solution from	Mutant test cells								
	qu-	*x*-	*dicin*-	*dipro*-	*dipha*-	*ty*-	*pha*-	*phlo*-	*ino*-
Quercetin	+	+	+	+	+	+	+	+	+
qu-Mutant (4)	−	+	+	+	+	+	+	+	+
x-Mutant (3)	−	−	+	+	+	+	+	+	+
dicin- "	−	−	−	+	+	+	+	−	−
dipro- "	−	−	−	−	+	+	+	−	−
dipha- "	−	−	−	−	−	+	+	−	−
ty- "	−	−	−	−	−	−	+	−	−
pha- "	−	−	−	−	−	−	−	−	−
phlo- "	−	−	−	−	−	−	−	−	+
ino- "	−	−	−	−	−	−	−	−	−

Of the twenty-five mutants, fourteen are activated by the C_6—C_3 compounds, five by the C_6 and the remaining six by the C_6—C_3—C_6 compound quercetin. By mixing these six mutants (3, 4, 7, 13, 19, 23) in pairs (Table 3) it is possible to show that they represent, in fact, only two biochemical types : 3, 7, 19 and 4, 13, 23, the former the *x*-mutant, the latter the *qu*-mutant, since the centrifugate from the *qu*-mutant activates the *x*-mutant and not vice versa (Table 2).

Table 3

	3	7	19	4	13	23
3		−	−	+	+	+
7	−		−	+	+	+
19	−	−		+	+	+
4	+	+	+		−	−
13	+	+	+	−		−
23	+	+	+	−	−	

Chemical experiments have also been instituted to confirm the presence of the accumulated substances. The mutant was grown on agar (equivalent to about ten Petri dishes) and extracted with alcohol. The evaporated solution was then examined by standard methods of paper chromatography using downward displacement. The solvents used were : (*A*) butanol–acetic acid–water (4 : 1 : 5) and (*B*) *m*-cresol–acetic acid–water (25 : 1 : 24), and in all cases the suspected substance was run on the same chromatogram and gave a spot of identical R_F. These values were (18–20°) : phenylalanine, *A*, 0·60, *B*, 0·88 ; tyrosine, *A*, 0·39, *B*, 0·40 ; 3 : 4-dihydroxyphenylalanine, *A*, 0·22, *B*, 0·15 ; 3 : 4-dihydroxyphenylpropionic acid, *A*, 0·89, *B*, 0·65 ; 3 : 4-dihydroxycinnamic acid, *A*, 0·87, *B*, 0·50 ; phloroglucinol, *A*, 0·75, *B*, 0·19 ; inositol, *A*, 0·07.

The spots were detected by appropriate reagents, for example, silver nitrate for the catechol derivatives, ninhydrin for the amino-acids. 3 : 4-Dihydroxycinnamic acid fluoresced in ultra-violet light, and phloroglucinol did so in presence of ammonia. Inositol was detected by spraying with silver nitrate and heating to 105° ; owing to the low R_F value, one chromatogram was allowed to drip off the paper ; the distance travelled was still the same as a known mesoinositol spot.

All steps except two represent known or probable biochemical transformations ; one step of great interest is the conversion of mesoinositol to phloroglucinol, which has been suspected before[6]. The other unknown stage is the apparent direct deamination of 3 : 4-dihydroxyphenylalanine to 3 : 4-dihydroxyphenylpropionic acid. It is possible that a mutant has been missed which produced 3 : 4-dihydroxyphenylpyruvic acid, but we have so far been unable to prepare this substance in a state of purity and it has not been detected in a mutant. A direct deamination by a reduction process is not improbable from the point of view of chemical mechanisms if the substrate involved is the conjugate acid from the amino group. A similar deamination in *Chlamydomonas* has also been observed in another connexion[7].

Full details of this work, and its bearing on the biosynthesis of other compounds containing C_6—C_3 units, will be discussed elsewhere. It may be remarked, however, that the intervention of phloroglucinol raises considerable difficulties in a general theory of the biogenesis of compounds containing less oxygen in this ring, and alternative theories are possible[8].

We are grateful to Timbrol, Ltd., the Dunlop Rubber Co., and the Rockefeller Foundation for

financial assistance, and to Mrs. L. Moewus for growing the cultures employed in this work.

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RELATION OF CHEMICAL STRUCTURE TO IRRITANT RESPONSES IN MARINE FISH

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FOR a variety of reasons, there has been an increasing demand for chemicals capable of repelling fish. In an attempt to fill this need, we have made a search for the most effective irritant chemicals for marine fish, and incidentally for the relationships of chemical structure to irritant responses. In a recent paper[1] we reported preliminary results of the study; but too few data were available at that time to assert these relationships with any degree of certainty. Now that more than five hundred selected compounds have been tested, certain relationships have become increasingly evident, and this brief account, with selected supporting data, serves to summarize them by presenting certain hypotheses which provide the basis for detailed analyses which will appear at a later date. It is hoped that this condensation will aid other workers conducting similar investigations by indicating those molecular characteristics which appear most active in inducing irritant responses in fish, particularly those mediated through the common chemical sense[2].

Hitherto, only scattered information on this subject had been secured when fish were accidentally or incidentally affected by insecticides[3] or pollutants[4], until an extensive search was made during the Second World War for chemicals repellent to sharks[5,6]. Our studies show that chemicals found most active in the latter tests are of little use as repellents for bony fish. Thus, this subject has been but barely touched.

A full account of the methods used, means by which chemicals were selected and certain ancillary considerations of the distribution of reacting substances in sea water were presented in our earlier paper[1]. Briefly, tests were conducted in aquaria with a capacity of 50 litres, in which a small school of four or five fish (*Kuhlia sandvicensis*) was exposed to chemicals dispersed or dissolved in sea water. The usual span of observation was limited to two minutes, because the prime objective was to discover rapidly-acting irritants. Responses varied from mild to severe, and upon a background of many observations these reactions were rated as slight, medium or violent. It was not feasible to make finer distinctions. Naturally, different types of responses were evoked by different irritant chemicals. For example, nearly all irritants attacking the common chemical sense produced excitation, body shaking and rather violent swimming. Substances reacting as respiratory poisons induced gulping, swimming at the surface and generally depressed activity. Certain substances evoked unusual responses such as tetanic and flaccid paralysis, operculum and fin distension, disorientation, convulsions, etc. These reactions we assume to be the result of very intense stimulation of the sensory receptors. Some substances which *a priori* might be expected to exhibit a degree of irritant action such as stenches (sulphides and mercaptans), organic cyanides (nitriles) and narcotics (aliphatic alcohols) had little or no visible effect during the brief period of the test. Although we discerned a number of rather discrete responses to different compounds, it was not always possible to define precisely symptoms characteristic of a particular compound or of a group of organic homologues, because of the widespread receptor system for the common chemical sense, and because of the interdependence of life processes.

In the course of our experiments it soon became apparent that certain types of chemicals possessed the irritant properties sought. In general, lachrymators and skin irritants were found to be the most effective of the physiologically active chemicals tested. Certain insecticides of the irritant type (pyrethrins) were moderately effective, as were respiratory poisons (for example, cyanide ion). Cyanide ions are known to inhibit respiratory enzymes, and the extensive work reported by Dixon and Needham[7] indicates that lachrymators and skin irritants operate through the inhibition of thiol groups in enzymatic systems. Of importance is the fact that the activity of the more highly irritant chemicals persists to a concentration which is still within the order of magnitude of that required to inhibit such enzymes (0·1 part per million).

Certain aspects of our experiments must be clarified, lest our results appear inconsistent in details with others reported in different circumstances. First, the two-minute span of each experiment eliminates from consideration such reagents as the mercuric ion which produces a mercaptide with the —SH group and does impart irritation to fish, but only after a much longer period[8]. Second, the most active alkylating agents, also inhibitors of the thiol groups, easily and rapidly hydrolyse and thus may be destroyed before reaching

Chemical	Dilution in parts per million				
	10·0	1·0	0·1	0·05	0·01
Phenacyl chloride	+ + +	+ + +	+ +	+	
Phenacyl bromide	+ + +	+ + +	+ + +	+ + +	+
2,4-Dimethyl phenacyl chloride	+ + +	+			
Benzyl chloride	+	−			
Benzyl bromide	+ + +	+ + +	+ + +	−	
Methyl *iso*thiocyanate	+ + +	+ + +	+		
Allyl *iso*thiocyanate	+ + +	+ + +	+ +	+	−
Nitrobenzene	+				
S-Trinitrobenzene	+ + +	+ +	+		
Benzoquinone	+ +	+			
Anthraquinone	+				
Potassium ferricyanide	+ +	+			
Potassium cyanide	+ + +	+ +	+		
Iodoacetic acid	+ +				
*iso*Bornyl thiocyanate	+ + +	+ + +	−		
Bromine	+ + +	−			
Chlorine	+ + +	+			

+ + + Indicates violent irritant activity; + + indicates moderate irritant activity; + indicates slight irritant activity; and − indicates no irritant activity

the sensory receptors. Such reagents, protected by dispersion in mineral oil, were nearly always an order of magnitude more active as irritants (powers of 10 in our dilution series) than when unprotected. Third, lipoid and aqueous solubility of irritant chemicals would radically modify the irritant qualities expected on the basis of other properties of the molecules.

Respiratory Poisons

Certain substances known to inhibit respiratory enzymes by attacking groups other than thiols were found rather active as irritants. Notable among these was the cyanide ion (see table), a well-known respiratory enzyme poison, which elicited surface swimming, gulping and depressed activity generally, precisely the type of behaviour expected in response to oxygen deficiency. Likewise, organic thiocyanates which are reputed to liberate hydrogen cyanide in animal tissue[9,10] were found to possess a rather uniformly high degree of irritant activity.

Thiol Inhibitors

Chemicals which inhibit thiol groups are sometimes divided into three categories[11]: (1) mercaptide-forming agents such as heavy metals and metalloids which displace the hydrogen of the thiol; (2) oxidizing agents which oxidize sulphydryl groups to disulphides; and (3) alkylating agents which replace the hydrogen of the thiol to form alkylated compounds. We consider all these mechanisms to be similar in that they involve either a complete loss of electrons (oxidation), or a replacement of a slightly electronegative hydrogen atom by a more electronegative atom (heavy metal or carbon of the alkylating group) with a consequent loss in the share of electrons held by the sulphur atom of the thiol group, that is, oxidation of the sulphur. We are also convinced that it is more than mere coincidence that these are precisely the substances which have been found to be most active as general irritants to fish. Chemical groups which impart the most irritant quality to molecules of this type are aliphatic and aromatic nitro compounds, nitroso compounds, halogenated substances with the halogen *alpha* to a carbonyl or phenyl group, halogens linked to a metal in metallo-organics, disulphides, quinones and compounds with a carbonyl conjugated to a double bond. It is noteworthy that many of these are considered to be typical alkylating agents[11]; but more significant is the fact that these are the types of molecules which are found by polarography to be reducible at the dropping mercury electrode, that is, they are oxidizing agents[12].

In dealing with irritant chemicals which are oxidizing agents, one would naturally try to relate irritant power to oxidizing potential. Such relationships were found to apply in a few cases where a series of very similar compounds were compared (for example, the halogens); but general correlations were not found or were rather tenuous. Correlations of this sort would be very difficult to make because of the lack of oxidation potentials for organic substances measured under conditions that would in any way be comparable to the lipoidal and *p*H conditions under which these chemicals react physiologically. Polarographic data, while helpful, are usually obtained for aqueous – organic solvent mixtures at a variety of *p*H values.

Of importance, too, is that substitution of electrophilic or electrophobic groups on the molecules affects the irritant activity to about the same extent as it is known to affect the reducibility of the reactant molecule, that is, its oxidizing power. Removal of electrons from the reactive groups by the inductive effect[13] of electrophilic or electron-attracting groups (—NO_2, —halogen), or by the similar electrophilic resonance or tautomeric effect of certain groups (—NO_2, —COOH), enhances the irritant activity of the group because it also increases the ease of reduction. Groups which exhibit an electrophobic character (for example, methyl) have an opposite effect. Caution must be exercised in adding electrophilic groups to augment irritant activity towards fishes, because this frequently enhances the hydrolysability of the compound.

In the accompanying table are shown a few selected examples of the irritant activity of chemicals which we believe inhibit the sulphydryl group through their action as alkylating or oxidizing agents. The action of mercaptide-forming agents, as already mentioned, is too sluggish to exhibit irritation within the brief span of the tests.

It was surprising that, among oxidizing agents, little or no irritant power seemed inherent in organic and inorganic peroxides within the range of concentrations normally used in these tests. Because of the great dilutions used, these substances probably reacted with oxidizable impurities present in sea water, and thus were consumed prior to contact with the fish. In support of this view, benzoyl peroxide, protected by mineral oil, imparted pronounced irritant activity. Moreover, hydrogen peroxide at higher concentrations (100·0 parts per million) proved to be a very effective irritant.

In summary, based on our results so far, we believe that the most violent irritant responses mediated through the common chemical sense of fish are stimulated by inhibition of sulphydryl groups of one or more enzymes associated with the sensory receptors. Based on this hypothesis, tests are being continued on many variations of molecules which serve as thiol inhibitors to learn the effects of substituents. As a corollary, combinations of chemicals likely to have synergistic action are being tested. For all highly active compounds, various methods of suspension in aqueous media are being tried to ascertain the best vehicle for conducting the irritant substance to the site of action prior to the advent of hydrolysis or of some other vicarious chemical reaction with sea water.

These studies were aided by a contract between the Office of Naval Research, U.S. Department of the Navy, and the University of Hawaii (NR 160–165).

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LETTERS TO THE EDITORS

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Qualitative Organic Micro-analysis based on Physical Constants: Identification of Amino-Acids

The usual way of identifying organic compounds consists in preparing a crystalline derivative and determining its melting temperature. Such preparation requires at least 50 mgm. of material. Compounds not showing distinctive properties (such as hydrocarbons), or only slightly reactive, also those decomposed by the reagents, do not easily yield characteristic derivatives.

Physical constants like density, solubility, refractive indices, melting and boiling points have already been used for identifying such organic compounds. In recent years, some of these constants have been used in special circumstances on the micro scale for identification purposes, as in biochemistry and atomic researches. The Linderstrøm-Lang density determination is well known for its accuracy[1]. More recently, methods based on melting points and refractive indices have been developed by A. Kofler and L. Kofler[2]. By these methods, it is possible, from observations made on one crystal alone, to make deductions about the purity of a compound and the nature of any contamination, and also to carry out a quantitative thermal micro-analysis. Eutectics play a big part in these methods, and as these eutectic mixtures always melt at lower temperature than either of the two partners, the observation of the beginning of melting gives precise results. Some of these eutectics melt at room temperature, and by proper selection they can be used to identify substances of the type mentioned above, or those decomposed by heating.

The amino-acids are a class of compounds of much present interest. They are very reactive, but rather fragile when heated. A great number[3] of their derivatives are known, but there are some gaps. Several of these derivatives also decompose on heating and are therefore useless for identification. Moreover, amino-acids are expensive, and where testing is frequent, the price of each determination has to be considered; a method requiring only one crystal is then preferable to one needing 50 mgm.

The density of twenty of these acids[4] has already been determined, but the results do not show great differences for closely related individuals; refractive indices are given in the literature for only three amino-acids[4]; no eutectic has been studied hitherto or used for the purpose of identification; solubility and rotatory powers[5] are extensively used, but conditions are not standardized, so that these are also useless for identification.

The present investigation has been developed with the view of providing data on eutectics and the refractive indices of amino-acids that can serve for rapid and easy identification of these compounds, either as crystals or as solute. These can be used for checking chromatographic separations on ion exchangers, where it is never certain that the isolated fraction effectively consists of only one known compound and no other. The techniques adopted here are those described in the literature[1,2,6]. Table 1 includes a short selection of results which can be recommended for identification purposes.

The refractive indices of these acids have been determined by an immersion method[7], using the crystals as they are deposited on the microscope slide (Table 2). These crystals are grown identically and all show the same aspect whatever their origin. The crystal is at first placed under the microscope between crossed nicols (parallel light, known temperature and filtered light) in the extinction position in a dark field. The analyser is taken away and the first index is determined in that position. Then the crystal is turned through 90° and the second index is determined. These two indices are arbitrary and called $n'p$ and $n'g$. This technique needs no special knowledge, and gives characteristic data that can be used for identification of these acids using even only one crystal recovered from a solution. The accuracy of the refractive index in this work is $\pm$ 0·001. Determination takes about one minute.

Very strong structural influences can be demonstrated by the melting point of binary mixtures of

Table 2. Refractive Indices of Amino-Acids (One Crystal)

Acids	$n'p$	$n'g$	$n'g-n'p$	$D20°$ (ref. 5)	Mol. refractivity: Experiment $\frac{n'g-1}{D} \cdot M$	Mol. refractivity: Theory
glycocol	1·495	1·650	0·155	1·607	30·3	27·3
ε-amino-caproic	1·504	1·536	0·032			
dl-valine	1·580	1·602	0·022	1·316	51·11	50·57
dl-*nor*valine	1·481	1·502	0·021			
dl-leucine	1·538	1·557	0·019	1·191	61·29	63·54
dl-*iso*leucine	1·552	1·581	0·029			
dl-*nor*-leucine	1·522	1·558	0·034	1·169	62·62	60·02
l(−)-tyrosine	1·550	1·680	0·130	1·456	83·56	83·36
α-alanine	1·515	1·575	0·060	1·424	35·91	36·69

Table 1. Binary Eutectics

Amino-acids	Eutectic partner	Melting point (° C.)	Amino-acids	Eutectic partner	Melting point (° C.)
glycocol	β-alanine	166–168	*dl*-*nor*leucine	tartaric acid	118
	ε-amino-caproic acid	193–195		malonic acid	<90
ε-amino-caproic acid	β-alanine	169		phthalic acid	111–115
	dl-*nor*leucine	188		aspirine	115–120
	dl-*iso*leucine	192–195		pyrogallol	99–100
	dl-aspartic acid	145–148	*dl*-aspartic acid	malonic acid	99–102
	l(+)-glutamic acid	154–156		tartaric acid	141–142
	dl-valine	198	*l*(+)-glutamic acid	tartaric acid	130
	dl-β-phenylalanine	186		malonic acid	<90
	l(−)-tyrosine	190–191		ascorbic acid	159–160
dl-leucine	glucose	138–139	*dl*-β-phenylalanine	malonic acid	105
	hippuric acid	173–174		0-hydroxy benzoic acid	139–140
	α-chloro-acetamide	109–110		thiourea	163–166
dl-*iso*leucine	mannitol	163–164	*l*(−)-tyrosine	oxalic acid	71
	hippuric acid	168–169		malonic acid	119–121
	α-chloro-acetamide	<100		tartaric acid	156

these acids as well as by the refractive indices. The method is therefore useful for identification of these substances. It can be extended to other groups of organic substances as a qualitative method of functional organic micro-analysis. These determinations, taking so little time and so little material, might be introduced as a general means of identification of compounds in the classical qualitative organic analysis of mixtures (Staudinger, Shriner, Fuson and Kamm) instead of the usual preparation of derivatives.

Quantitative aspects of this work are now being studied by us.

These investigations have been supported by a grant from the Belgian F.N.R.S. Institute.

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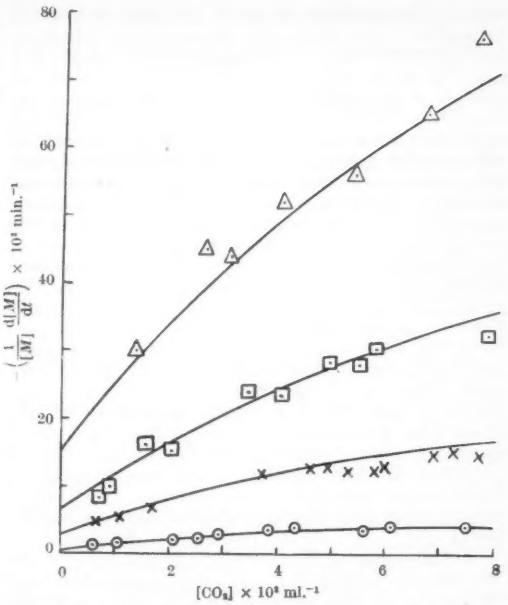

Catalysis by carbon dioxide of the polymerization of sarcosine N-carbonic anhydride in nitrobenzene at 25°.
△, $[X]_0 = 1{\cdot}58 \times 10^{-2}$ mol. l.$^{-1}$. ×, $[X]_0 = 0{\cdot}75 \times 10^{-2}$ mol. l.$^{-1}$.
□, $[X]_0 = 1{\cdot}09 \times 10^{-2}$ mol. l.$^{-1}$. ○, $[X]_0 = 0{\cdot}37 \times 10^{-2}$ mol. l.$^{-1}$.
The continuous curves are calculated from equation (3) using the following values of the constants: $K_1 = 60{\cdot}6$ mol.$^{-2}$ l.^{2}; $Kk_1 = 5\ 8 \times 10^3$ mol.$^{-2}$ l.^{2} min.$^{-1}$; $Kk_2\sqrt{K_1K_2} = 1{\cdot}8 \times 10^3$ mol.$^{-3/2}$ l.$^{5/2}$ min.$^{-1}$; $Kk_2K_1K_2 = 3{\cdot}2 \times 10^4$ mol.$^{-2}$ l.^{2} min.$^{-1}$

Kinetics of the Formation of Polypeptides from N-Carboxy-α-amino-acid Anhydrides

The well-known synthesis of polypeptides from N-carboxy-α-amino-acid anhydrides has been extensively used recently for preparative purposes, but the mechanism of the reaction has received comparatively little attention. The only publication dealing with the kinetics seems to be that of Waley and Watson[1], who studied the polymerization of sarcosine N-carbonic anhydride. These authors concluded that the reaction mechanism is surprisingly complicated; the order with respect to monomer appeared to be less than 1 initially, but approached unity towards the end of the reaction. Further, when preformed polymer was used as initiator, the dependence of the rate on initiator concentration was represented by a power of the latter lying between 1 and 2.

In carrying out a more extensive study of these polymerizations we have recently had occasion to repeat some of the work of Waley and Watson; this has resulted in our finding a hitherto unsuspected feature of the reaction which necessitates a new approach to the problem. Working with a constant-pressure apparatus, we have found that the reaction in nitrobenzene is strictly first-order in monomer concentration throughout. It is, however, strongly catalysed by carbon dioxide. The accompanying diagram shows the variation of the first-order rate coefficient $(-\mathrm{d}\log[M]/\mathrm{d}t)$ with carbon dioxide concentration at 25°, for a series of different initiator concentrations. We have shown that there is a definite uncatalysed reaction at zero carbon dioxide concentration. Since Waley and Watson worked with a constant-volume apparatus, the steadily increasing pressure would result in a corresponding increase in rate constant in their experiments, leading to the apparent change in the order with respect to monomer. We find that the order in initiator concentration is very close to 2, and further that the reaction has a negative temperature coefficient as noticed by Waley and Watson.

We interpret these results as showing that some stage of the reaction is subject to acid catalysis. In solutions containing primary or secondary amines and carbon dioxide, equilibria of the following type will exist:

$$2R\mathrm{NHMe} + \mathrm{CO_2} \overset{K_1}{\rightleftharpoons} R\mathrm{NMeCOO}^-\ \overset{+}{\mathrm{NH_2}}\mathrm{Me}R \overset{K_2}{\rightleftharpoons} R\mathrm{NMeCOO}^- + \overset{+}{\mathrm{NH_2}}\mathrm{Me}R \quad (1)$$
$$\Updownarrow K_3$$
$$R\mathrm{NMeCOOH} + \mathrm{NHMe}R$$

The species $\overset{+}{\mathrm{NH_2}}\mathrm{Me}R$ and RNMeCOOH might be expected to function as acid catalysts. Following Waley and Watson, we assume that the first step in the reaction is the reversible formation of a complex Y from the monomer M and the base X (reaction 2a). The complex may decompose with ultimate evolution of carbon dioxide by reaction with a further molecule of base (2b), or by different processes (2c) requiring the presence of acid catalysts.

$$\left.\begin{aligned} &M + X \rightleftharpoons Y, K && (a)\\ &Y + X \xrightarrow{k_1} (\text{carbamate salt}) \rightarrow 2X + \mathrm{CO_2} && (b)\\ &Y + \begin{Bmatrix} \mathrm{XH^+} & \text{or} \\ R\mathrm{NMeCOOH} & \end{Bmatrix} \xrightarrow[k_3]{k_2} X + \mathrm{CO_2} + \begin{Bmatrix} \mathrm{XH^+} & \text{or} \\ R\mathrm{NMeCOOH} & \end{Bmatrix} && (c) \end{aligned}\right\} (2)$$

The rate equation deduced from this scheme is

$$-\frac{d[M]}{dt} = K[M]\left\{\frac{(1+8K_1[CO_2][X]_0)^{1/2}-1}{4K_1[CO_2]}\right\}^2$$

$$\times \{k_1 + k_2\sqrt{K_1K_2}[CO_2]^{1/2} + k_3K_1K_3[CO_2]\}, \quad (3)$$

where $[X]_0$ is the initiator concentration. In deriving this equation, it has been assumed that the equilibrium (2*a*) is effectively established throughout the reaction, and that $[Y]/[X]$ is small. The values of the rate calculated from (3) are shown as a function of the carbon dioxide concentration in the full curves in the diagram, using the numerical values of the various combinations of constants shown in the legend. The agreement with experiment is considered satisfactory.

Some support for the above mechanism is provided by the observation that addition of a weak acid—α-picolinic—in concentrations of about 10^{-2} molar (that is, of the order of 10 per cent of the initiating base) causes a marked increase in the rate of reaction. Further, in agreement with the postulated mechanism, the molecular weights of the polymer produced are independent of the concentration of added acid—whether α-picolinic or carbamic—although the rate of polymerization changes considerably.

We have found that the polymerizations of the N-carbonic anhydrides of DL-phenylalanine and DL-leucine in nitrobenzene solution are completely different kinetically from that of sarcosine. In these cases the reactions are first-order with respect to both monomer and initiator, and have positive temperature coefficients. Carbon dioxide shows no catalytic effect. It appears that with these anhydrides the rate-determining step is the forward reaction of (2*a*).

A fuller account of this work will be published elsewhere in due course.

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Paper Electrophoresis of Sugars at High Potential Gradients

It has been shown by Consden and Stanier, Jaenicke, and others[1] that the application of electrophoresis on filter paper can give interesting results for the resolution of mixtures of certain sugars in borate buffers. Most workers used potentials of 200–300 V. and various systems of cooling, or no cooling at all. Although the separations of several hexoses and pentoses from one another and from some disaccharides and trisaccharides have been accomplished, the resolution of mixtures of disaccharides and higher oligosaccharides seemed to be more difficult and often not possible.

Foster[2] has reported the use of up to 1,200 V. or 24 V./cm. in the electrophoresis of carbohydrates, including some disaccharides, thus doubling the voltage of 10·3 V./cm. applied by Consden and Stanier. Michl[3] described the separation of mixtures of sugars, mainly hexoses and pentoses, applying a potential gradient of 44 V./cm. for 15 min. with an efficient cooling system at 10° C. While this work was in progress, the information of the use of very high potential gradients (50–120 V./cm.) by Kickhöfen and Westphal[4] for the separation of peptides came to our knowledge rather belatedly.

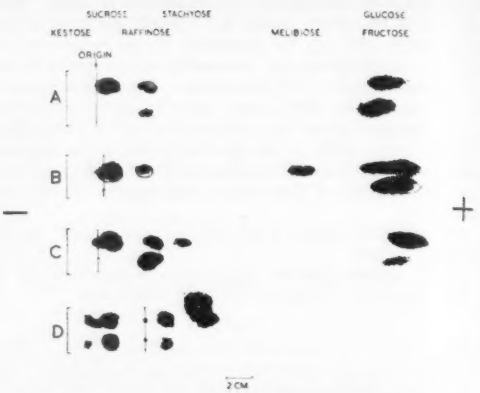

Fig. 1. Electrophoresis of sugars. (*A*) Sucrose, raffinose, fructose; (*B*) sucrose, raffinose, melibiose, glucose; (*C*) sucrose, raffinose, stachyose, fructose. Conditions: 40 V./cm., 8–12 m.amp., 1½ in. × 22½ in. strip, Whatman No. 1, 0·05 *M* sodium borate solution, *p*H 9·2, 1·5 hr.; (*D*) kestose, sucrose, raffinose, stachyose; same conditions, but run for 3 hr. with origin line in centre of strip instead of 9 in. from cathode end; 5–20 μgm. of each sugar applied. Spraying reagent: α-naphthol and phosphoric acid; benzidine and acetic acid in (*B*)

Since the distance travelled within a given time is a function of, and directly proportional to, the applied potential, it was thought that a significant increase in the voltage and the use of a longer strip might make conditions more favourable for successful separations.

We have found in this laboratory that the application of high voltage is not difficult, once the problem of efficiently cooling the strip of paper has been solved. The dissipation of the considerable amount of heat generated had been first achieved by placing the strip between two sheets of ordinary window glass which, in turn, are placed between two copper plates cooled by tap water. This system has been later improved on by substituting polythene or telcothene films (Telegraph Construction and Maintenance Co., Ltd., London) of 0·006 in. thickness for the glass sheets. This ensures better cooling and easier handling of the apparatus, which will be described in detail elsewhere. Strips of 1½ in. × 22½ in. were mainly used, allowing an effective length of about 20 in. For some experiments, strips of 5 in. × 22½ in. were found useful. Potential gradients of 40–60 V./cm. have been applied for 1–3 hr. without difficulties. Depending on the compounds involved, satisfactory separations can be obtained within 1 hr. Fig. 1 demonstrates some of the separations.

The interesting point is that both raffinose and stachyose travel faster towards the anode than sucrose, which is contrary to their behaviour on a paper chromatogram. Glucose and fructose are not separated under these conditions, but can be resolved at a lower *p*H. Kestose, a new trisaccharide[5], can be easily separated from raffinose, contrary to its chromatographic behaviour. Its separation from sucrose is sufficiently clear provided their proportions are not too unfavourable.

It must be pointed out that the picture of the separations (Fig. 1) has suffered by the photostat method of copying adopted. The spots in *B* had to be ringed as the benzidine reagent did not give suitable

contrast for copying. The high-voltage technique seems to offer a number of advantages, as present work in this laboratory on the separation of incompletely inverted sucrose has already shown. The high degree of resolution and the great saving of time are only two of them.

Thanks are due to Mr. H. C. S. de Whalley, director of research, for his interest in this work, and to the Directors of Tate and Lyle, Ltd., for permission to publish this communication.

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Analysis of Organic Hydroperoxides in the Presence of Hydrogen Peroxide

The problem of identifying and estimating accurately organic hydroperoxides in the presence of hydrogen peroxide has recently been solved in these laboratories by two different techniques.

It has been found possible, by the use of filter paper chromatography, to resolve synthetic mixtures of hydrogen peroxide with such peroxides as methyl- or *t*-butyl hydroperoxides. The experiments were carried out with Whatman No. 1 papers placed, in the usual way, between two glass plates. Hydrogen peroxide and methyl peroxide were then separated by developing the chromatogram with ether, and showing the positions of the rings with a thiocyanate reagent. Hydrogen peroxide and *t*-butyl peroxide were conveniently separated with propyl alcohol, and the rings shown up with the usual reagents. The R_F values found were: in ether, hydrogen peroxide 0·4, methyl peroxide 1·0; in *iso*-propyl alcohol, hydrogen peroxide 0·74, *t*-butyl peroxide 1·0.

The first method is mainly qualitative, unless the chromatograms are compared with others obtained with standard mixtures of peroxides. The polarographic method has been applied to the quantitative estimation in two ways. One of these depends on the observation that in an alkaline medium (0·1 *M* lithium sulphate, 0·01 *M* lithium hydroxide), hydrogen peroxide gives two waves. There is first an anodic step with $E_{1/2} = -0{\cdot}1$ V. (against a standard calomel electrode), and then the well-known, slowly rising cathodic step, with the approximate relation $E_{1/2} = -0{\cdot}9$ V. The diffusion currents of hydrogen peroxide which correspond to these steps have equal and opposite values. The presence of organic hydroperoxides has been found to contribute only to the second, cathodic step, though with different diffusion currents (these results will be published in a later communication). It is thus possible to derive the total concentration (hydrogen + organic peroxides) from the cathodic step, and that of hydrogen peroxide only from the anodic step.

If the concentration of hydrogen peroxide is much greater than that of the organic peroxides, then the following modification is more suitable. The hydrogen peroxide is precipitated, in an alkaline medium of 0·2 *M* lithium sulphate and 0·05 *M* lithium hydroxide, by reaction with lanthanum acetate (0·01 *M*). An irreducible basic peroxide of lanthanum is formed, so that a polarogram now reveals only the presence of the organic peroxide. The hydrogen peroxide can then be liberated by acidifying the solution. The lower limit of detection is *c.* 10^{-5}–10^{-6} *M* peroxide.

The methods described are now being applied to the analysis of combustion products.

We wish to thank Sir Alfred Egerton for his guidance and encouragement in this work.

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Kinetics of Porphyrin-catalysed Chemiluminescent Decomposition of Peroxides, and the Mechanism of Photosensitized Oxidation

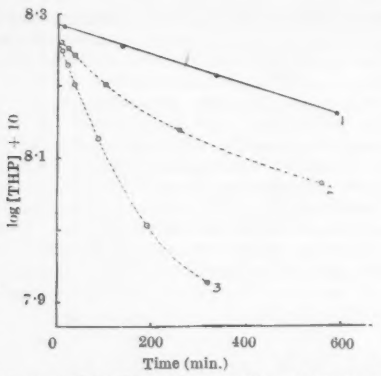
A reciprocal relation between photochemical and chemiluminescent reactions is to be expected. In one case, absorbed light leads to chemical action, and in the other, chemical processes result in light emission. As part of a study of the mechanism of dye-sensitized photo-oxidations we have therefore investigated the kinetics of the chemiluminescent reaction between certain dyes and organic peroxides which was discovered by Helberger[1]. For example, magnesium phthalocyanine will catalyse the decomposition of tetralin hydroperoxide in hot hydrocarbon solvents, and this catalysis is accompanied by a bright chemiluminescence[1,2]. Zinc tetraphenylporphine and chlorophyll will also luminesce in these hot hydrocarbon–peroxide systems[2–4].

The reaction between zinc tetraphenylporphine[5] and tetralin hydroperoxide[6] was studied at 149° C. in *tert.*-butylbenzene solvent, chosen because of its high boiling point and low chain transfer constant[7]. All materials were carefully purified, solutions were rigorously de-oxygenated on the vacuum-line and reactions were run in sealed-off tubes. The dye was followed spectrophotometrically, the peroxide by a precise iodometric titration[8], and the emitted light measured by a photomultiplier photometer.

Typical results are given in the accompanying figure and table, showing respectively the catalytic effect of the porphyrin on the peroxide decomposition and data on the time course of the luminescence. The falling-off of the catalytic effect with time is

Chemiluminescent Reaction between Tetralin Hydroperoxide and Zinc Tetraphenylphorphine
Run, *L*-3; temperature, 149° C.; solvent, *t*.-butylbenzene

Tube No.	Time (min.)	[Tetralin hydroperoxide] $\times 10^2$ mol. $l.^{-1}$	[Zinc tetraphenylporphine] $\times 10^5$ mol. $l.^{-1}$	Light intensity ΔG (photometer reading)	$\frac{k_1}{[P][D]\times 10^5}{\Delta G}$
0	0	1·900	9·20	172	1·02
3	31·5	1·813	6·79	124	0·99
2	66·5	1·702	4·67	78	1·02
1	99·5	1·631	3·32	49	1·11



Catalytic effect of ZnTPP on decomposition of tetralin hydroperoxide: (1) pure THP; (2) [ZnTPP] = $8{\cdot}08 \times 10^{-5}$ *M*; (3) [ZnTPP] = $3{\cdot}35 \times 10^{-4}$ *M*. Solvent, *t*.-butyl benzene; temperature, 149·0° C.; $[THP]_0 = 0{\cdot}02$ *M*

due to the gradual destruction of the dye. The essential results are as follows.

(1) At constant peroxide concentration the increase in the initial rate of peroxide decomposition above the uncatalysed unimolecular rate, caused by addition of dye, is proportional to the initial dye concentration.

(2) The initial rate of disappearance of dye is given by (*D* = dye, *P* = peroxide)

$$-\frac{d[D]}{dt} = k_D[D][P],$$

$k_D = 0{\cdot}5 \pm 0{\cdot}1$ l. mol.$^{-1}$ min.$^{-1}$, and, roughly, between 20 and 30 peroxide molecules are decomposed for each dye molecule consumed[2].

(3) The luminescence intensity is given quite accurately by

$$I = k_I[D][P].$$

(4) Cumene hydroperoxide and *tert*.-butyl hydroperoxide are very much less effective luminescent agents than tetralin hydroperoxide, in the reaction with zinc tetraphenylporphine. Di-*tert*.-butyl peroxide gives no visible emission at all.

In addition, from other work it is known that:

(5) α-Tetralone and water are the main products of the peroxide decomposition[2].

(6) In the case of chlorophyll, the chemiluminescence spectrum resembles the fluorescence spectrum of the original dye[9].

These facts are all consistent with the following mechanism for the peroxide–porphyrin reaction

($>\overset{H}{C}OOH$ = tetralin hydroperoxide; DH_2 = dye; DH_2^* = excited dye).

$$(A)\quad >\overset{H}{C}OOH + DH_2 \rightarrow >\overset{H}{C}O\cdot + DH\cdot + H_2O$$

$$(B)\quad >\overset{H}{C}O\cdot + DH\cdot \rightarrow DH_2^* + >C{=}O$$

$$(C)\quad DH_2^* \rightarrow DH_2 + h\nu.$$

Assuming reasonable values of the bond-strengths, the second step supplies enough energy to permit emission of a red photon. It is possible that the reaction proceeds generally without appreciable separation of the high-energy intermediates, which may be formed after initial complexing of the peroxide at the central metal atom. However, some side reactions must occur, as shown by the eventual disappearance of the dye. It is especially noteworthy that step (*B*) in the above mechanism is precisely the reverse of the initial step in a possible mechanism of photosensitization, in which the excited dye (or a long-lived excited product) is assumed to react with an acceptor to yield a pair of radicals[10,11]. Thus (*A* = oxidant, RH_2 = reductant):

$$(D)\quad DH_2^* + A \rightarrow DH\cdot + AH\cdot$$

$$(E)\quad DH\cdot + RH_2 \rightarrow DH_2 + RH\cdot$$

$$(F)\quad AH\cdot + RH\cdot \rightarrow AH_2 + R$$

Finally, we note that the complete reversal of the scheme of hydroperoxide decomposition leads to the splitting of water[12]. In the particular case studied here, it appears that there is insufficient energy in DH_2^* to run the process backward. However, one may conjecture that, in plant photosynthesis, water may be split between *two* radicals formed by hydrogen or electron transfer from the excited dye to a suitable acceptor.

Other mechanisms may be written, including those which do not assume removal of hydrogen from the catalyst. Thus, the initial step may be addition of peroxide across a double bond, with subsequent elimination of water, formation of ketone and regeneration of dye. However, this leads to some difficulty in understanding the mechanism of electronic excitation of the dye.

Further details of these and related experiments will appear shortly. This work is supported by grants from the Research Corporation of New York and the U.S. Atomic Energy Commission (Contract No. *AT*(30–1)–820). We are indebted to Prof. James Franck for helpful discussion.

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5-Hydroxytryptamine in a Carcinoid Tumour

ERSPAMER[1] was the first to assume enterochromaffine cells of the gastrointestinal tract to contain enteramine (5-hydroxytryptamine serotonin). Feyrter[2] regarded these cells as a part of the entity he calls the "Helle-Zellen-Systeme" in general, subdividing it into the "Insuläres Gangorgan" of the pancreas, the probable origin of glucagon (Gaede, Ferner and Kastrup[3]), and the "Gelbe-Zellen" or enterochromaffine cells of the gastrointestinal tract. Carcinoids, which are tumours originating from these cells, have

already been examined with regard to pharmacodynamically active substances by Feyrter and Unna[4] and by Selberg[5]. Their results were inconclusive and divergent.

A carcinoid found at post-mortem has been extracted with $N/50$ hydrochloric acid. This extract, administered in amounts corresponding to as little as 5 μgm. tumour (fresh weight) on an isolated rat's uterus (2-ml. bath), showed remarkable activity. Detailed pharmacological analysis (rat's uterus and colon; guinea pig's and rabbit's ileum; desensibilization by large doses of 5-hydroxytryptamine; blood pressure; innervated and denervated nictitating membranes; perfusion of rabbit's ear; paper chromatography with 70 per cent *iso*propanol : 30 per cent $N/10$ hydrochloric acid; and diazo and quantitative colorimetric estimations) revealed the presence of at least 2·5 mgm. 5-hydroxytryptamine per gm. tumour (fresh weight). A second substance, also active on the gut, but not inhibited by a large dose of 5-hydroxytryptamine, which did not give a diazo reaction and had a lower R_F value, could be distinguished from 5-hydroxytryptamine. It seems to be responsible for about half the activity on the guinea pig's ileum. Acetylcholine, histamine, adrenaline and substance *P* could be excluded.

These findings are in complete corroboration with Erspamer's assumption on the origin of 5-hydroxytryptamine. Furthermore, they can be regarded as a support for Feyrter's views on the functional unity and the significance of the enterochromaffine cells as an endocrine organ.

Details of this work will be published in the *Arch. Exp. Path. Pharmakol.*

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Rates of Glycolysis in Human Red Cells in Relation to Energy Requirements for Cation Transport

The extrusion of sodium and accompanying potassium accumulation by red cells against electrochemical gradients is linked to the energy of cell glycolysis[1,2]. Active cation transport ceases at low temperatures, in the presence of iodoacetate or fluoride, and in the absence of glucose. *Per contra*, the process is unrelated to red-cell respiration, since transport is not influenced by cyanide, azide, carbon monoxide, methylene blue, pyruvate or malonate.

Solomon[2] has discussed the energetics of sodium–potassium transfer across the human red-cell membrane. In fresh blood incubated at 37° C., the rate of disappearance of glucose was 2·33 m*M*./l. red cells/hr. Using the value of 48,000 cal./mol. for the anaerobic metabolism of glucose, the energy released was 110 cal. Evaluation of the exchange of sodium-24 and potassium-42 indicated that maintenance of the cation steady state could utilize a *maximum* of 8 per cent of the total energy released by red-cell glycolysis. Raker *et al.*[3] reported a glucose utilization of 1·4 m*M*./l. red cells/hr. for comparable systems and rates of cation transport. In blood incubated with glucose at 37° C. after cold-storage for 2–7 days, the glucose utilization ranged from 1 to 1·5 m*M*./l. red cells/hr.[1,4].

While in the latter experiments it may be assumed that the leucocytes are either absent or non-viable, the former investigators have apparently not assessed the glycolytic activity of white cells. Hsu[5] found dogs' white cells to have about a thousand times the glycolytic activity of red cells. The relative effect of human red and white cells on blood glycolysis has been studied during an investigation on cation transport (to be published).

Fresh heparinized blood from young healthy adults was divided into two unequal portions, the smaller being kept at room temperature. The larger sample was spun, the plasma removed and retained. The buffy coat and upper red-cell layer were aspirated and discarded. The packed red cells were suspended in an equal volume of original plasma (one tube refrigerated at 4–8° C.) and of buffer (sodium chloride, sodium bicarbonate, glucose at *p*H 7·8); counts on such suspensions showed less than 100 white cells per c.mm.

The samples (whole blood, red cells in plasma and in buffer) were incubated at 37° C. for 3 hr. after equilibration with 5 per cent carbon dioxide. Eighteen specimens utilized glucose at rates of 1·2–2·2 m*M*./l. formed elements/hr., compared with 0·9–1·35 (mean, 1·18) m*M*./l. red cells/hr. for red cells suspended in their own plasma and 5–10 per cent less in the buffer medium. Standardized to a hypothetical blood containing 5×10^6 red cells and 5×10^3 white cells per c.mm., the white cells are responsible for about 25 per cent of the total glucose utilization.

Lactic acid formed in the whole blood samples corresponded to 70–90 per cent of the glucose which disappeared. For the red-cell suspensions it was 91–98 per cent; such quantitative conversion is supported by other workers[1,5]. The slight respiration of red cells (Q_{O_2}, 0·05) appears to be related to the oxidation of glucose-6-phosphate through phosphogluconic acid to triosephosphate rather than the citric acid cycle[6].

Glycolysis exhibits progressive inhibition above and below *p*H 7·0–7·8. However, *p*H values after 3 hr. incubation did not decrease more than *p*H 0·2 from initial levels of *p*H 7·2–7·4 and 7·6–7·8 for the plasma and buffer suspensions. Longer incubation accelerated the change.

The energy of glycolysis is 36,000 cal./mol. glucose; of this, the free energy capture is represented by the net gain of two high-energy phosphate bonds of adenosine triphosphate, that is, 23,000–24,000 cal./mol. glucose[6,7]. Hence the utilizable free energy is some 28 cal./l. red cells/hr.

The plasma and red cell sodium and potassium values did not alter more than 0·5 meq./l. during incubation. The maximum free energy required for sodium and potassium transport in the steady state is 1,510 and 2,350 cal./mol. (calculated from the formulation of Ussing[8] and assuming that the cations are freely exchangeable). In the steady state, the outward movement of sodium-24 is 3·08 meq./l. red cells/hr.[2], and the inward flux of potassium-42 is 1·5–1·7 meq./l. red cells/hr.[2,3]. Transport of these ions thus requires a maximum of 4·65 and 3·8 cal./l. red cells/hr. Cation balance of red cells may, there-

fore, utilize up to a third of the available free energy from glycolysis.

The red cell suspensions, refrigerated at 4–8° C. for 1–3 days, showed decreases of red-cell potassium of 5–20 meq./l., with somewhat greater sodium increases. When incubated with glucose at 37° C. for 3 hr., the energy calculated to restore normal cell cation relations did not exceed the available free energy.

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Protective Activity of Cysteinamin against the Toxicity of Dihydrostreptomycin

It has been demonstrated by L. E. Floberg, C. A. Hamberger and H. Hyden[1] that the cells of the ganglion of Scarpa in guinea pigs, intoxicated with streptomycin, showed a definitive decrease of ribonucleic acid content.

We have performed experiments which show a diminution of ribonucleic acid in the cells of the ganglion of Scarpa in rabbits intoxicated with dihydrostreptomycin. In a normal rabbit the protoneurons of that ganglion present a very variable charge of basophilic substances (as demonstrated by Brachet's method). Three schematic types have been distinguished, according to the decreasing contents of ribonucleic acid. Most of them display a very large number of Nissl's bodies (Type I, Fig. 1). In others those bodies form only a perinuclear or peripheral layer (Type II, Fig. 2). Others still are practically empty of them (Type III, Fig. 3).

It appeared that, in the ganglions of fifteen rabbits intoxicated with dihydrostreptomycin up to loss of the labyrinthic reflexibility, the number of protoneurons poorer in basophilic substances was more important than in fifteen controls of the same age. This was confirmed by counting a sufficient number of cells and by distributing them into three groups corresponding to the three different classes according to the classification mentioned (see table).

	Type I (per cent)	Type II (per cent)	Type III (per cent)
Controls	55 42	35 48	10 10
After Dihydrostreptomycin	14 10	47 48	39 42
After cysteinamin Dihydrostreptomycin	58 32	40 60	2 8

We have already shown[2] that the toxic effect of dihydrostreptomycin can be eliminated by preliminary injections of cysteinamin (for details about the experimental conditions, see ref. 2). In those cases the vestibular reflexes remain normal and the microscopic examination of the ganglion of Scarpa from the fifteen rabbits protected by cysteinamin reveals an aspect similar to that of a normal ganglion of Scarpa.

The table indicates the percentage of the three above-mentioned types of cells after classification of 250 cells from two controls, two animals intoxicated by dihydrostreptomycin and two animals previously protected by cysteinamin.

Moreover, it has been observed that dihydrostreptomycin precipitates ribonucleic acid *in vitro*, possibly by formation of an insoluble complex. A concentration of 250 γ or more of dihydrostreptomycin with a constant quantity of ribonucleic acid (2,000 γ per c.c.) induces a precipitation which does not appear for the same concentration of ribonucleic acid when more than 200 γ cysteinamin is added. The mechanism of this process and its possible relation with our biological observations, however, will be further investigated.

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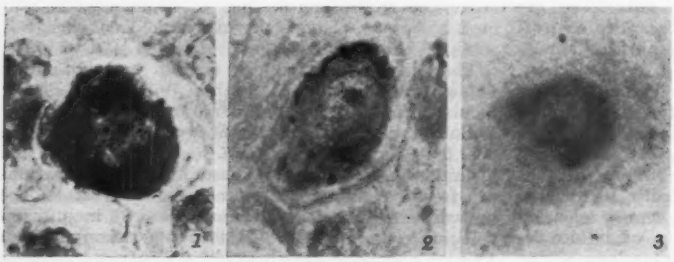
Turbidity-reducing Activity of Influenza Virus and Receptor-destroying Enzyme on Sheep Submandibular Mucoid

A characteristic turbidity develops when polymerized hyaluronic acid is mixed with acidified horse serum; this turbidity, and its destruction by prior incubation with hyaluronidase, is the basis of the turbidity-reducing test for the enzyme[1]. Solutions of highly purified mucoprotein from the salivary glands of sheep[2] also develop turbidity when treated under suitable conditions with acidified horse serum. Moreover, development of turbidity is significantly reduced by previous incubation of the mucoprotein with certain strains of influenza virus, or with the receptor-destroying enzyme of *V. cholerae*. In this preliminary communication we show that the turbidity-destroying activity of influenza virus is associated with the virus particles themselves, and is presumably a function of the enzymatic properties of the virus[3].

Mucoprotein solutions used included several partially purified preparations and one, homogeneous



Figs. 1–3. The three schematic types of ganglionary cells defined in the text. (1) A cell full of Nissl's bodies; (2) a cell with only a peripheral layer of Nissl's bodies; (3) a cell with no Nissl's bodies

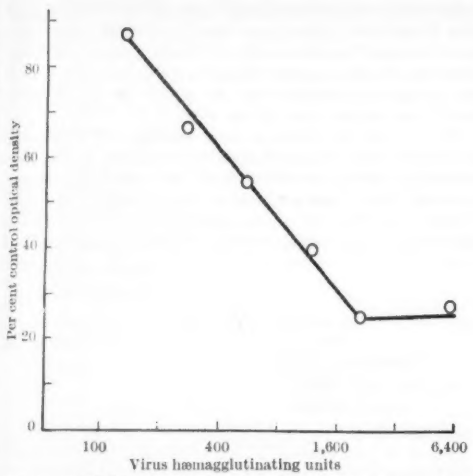


Fig. 1. Turbidity reduction by concentrated *WS* influenza virus on homogeneous sheep salivary mucoprotein

on electrophoresis and ultracentrifugation, which inhibited agglutination[4] by indicator *LEE* influenza virus at a concentration of 0·001 μgm./ml. All preparations became turbid when mixed with acidified horse serum, the purest preparations giving rise to the highest turbidity per unit weight. For turbidity-reducing assay, the concentration of mucoprotein was adjusted to give an optical density of 0·20–0·25 unit on the colorimeter.

The method of assay was essentially similar to that used for the turbidimetric assay of hyaluronidase: 0·1 ml. of mucoprotein (4–8 mgm./ml. in distilled water, depending on the purity of the sample used) was distributed in small tubes, and 0·1 ml. of saline buffered at *p*H 5·4 with 0·2 *M* acetate buffer containing 0·1 per cent calcium chloride was added to each tube. Serial dilutions of virus or enzyme (0·1 ml.) in buffered saline were then added, and the tubes incubated in a water-bath at 37° for 1½ hr. Control tubes with heat-inactivated (56° for 15 min.) virus or enzyme were included in each assay. On removal from the bath, 4 ml. of 0·5 *M* acetate buffer *p*H 3·8 was added to each tube, followed by 1 ml. of horse serum diluted 1 : 5 in acetate buffer and adjusted to *p*H 3·8. After mixing, the turbidities were developed for 30 min. at room temperature and read against a blank solution of buffer and horse serum in a Coleman spectrophotometer at 450 mμ.

The effect of incubating mucoprotein with falling amounts of influenza *A* virus, strain *WS*, purified by high-speed centrifugation, is shown in Fig. 1. A significant reduction in turbidity occurred after exposure to virus. Over a certain range (approximately 200–2,000 hæmagglutinating units) the reduction was directly proportional to virus concentration. At more than 2,000 hæmagglutinating units, however, turbidity was not further reduced with increased virus concentration; this residual turbidity varied between 5 and 30 per cent of the original turbidity, depending on the purity of the mucoid sample. No significant reduction in turbidity occurred after incubation with normal allantoic fluid or heat-inactivated virus.

The optimum reaction for destruction of turbidity was between *p*H 5·4 and 5·8. The destruction was stimulated by calcium ions and partly, though not entirely, suppressed by anti-calcium agents and specific antiserum. Reduction of turbidity by purified virus was 75 per cent complete after incubation for 30 min. and 85 per cent complete after 1 hr. It was shown most consistently by strain *WS*, either as high-titre allantoic fluid, or when deposited at 20,000 *g* and resuspended in Ringer's solution. Strain *Melbourne* was approximately twice as active as *WS* per hæmagglutinating unit; but with this strain only approximately one in three high-titre crude allantoic fluids showed the effect. Reduction of turbidity by *Melbourne* virus could, however, be consistently demonstrated with pooled virus passed at limiting dilution and deposited by high-speed centrifugation. Virus (*WS* or *MEL*) was more active per hæmagglutinating unit after centrifugation and resuspension in Ringer's solution than in the original allantoic fluid. The turbidity-reducing agent of resuspended virus was also considerably more stable than that of virus in allantoic fluid, which showed a marked drop in activity after 24–48 hr. at 4°. No turbidity-reducing activity has so far been demonstrated by concentrated *neuro-WS*, or by *PR8*, *A′*, *NDV*, *LEE B*, and mumps viruses in high-titre allantoic or amniotic fluids.

A marked and rapid drop in turbidity occurred when salivary mucoprotein was incubated with purified *V. cholerae* receptor enzyme[5] under the above conditions. Heated enzyme was entirely without effect. As little as 1 μgm. of pure enzyme produced a significant drop in turbidity: studies of the kinetics of the reaction indicated that it was complete in 30 min. and typically enzymatic.

The purified virus inhibitor from human urine[6] also developed turbidity with acidified horse serum, and this turbidity was reduced by at least 50 per cent after exposure to virus or receptor enzyme. None of the receptor-substance mucoproteins isolated from human erythrocytes[7], however, developed turbidity under the same conditions.

From the above results it may be concluded that allantoic fluid infected with certain strains of influenza *A* virus contains a factor which reduces the turbidity produced by mixing purified mucoprotein virus inhibitors with acidified horse serum. It is probable that the turbidity-destroying factor is associated with the virus particles themselves, since the effect is best shown by virus purified by high-speed centrifugation, or by adsorption to, and elution from, erythrocytes. No activity is shown by normal allantoic fluid, by infected fluids with hæmagglutination titre of less than 500, or by allantoic fluid from which virus has been deposited by centrifugation. Further, it is likely that turbidity-destroying activity is a function of the viral receptor-destroying enzyme, as may be seen from its thermolability, sharp *p*H optimum, and, most significantly, by its duplication in all respects by purified receptor-destroying enzyme of *V. cholerae*.

A purely physico-chemical method for the estimation of the receptor enzymes of influenza virus and *V. cholerae* offers obvious advantages over previous methods[8] dependent on red-cell agglutination, which give subjective and comparatively inaccurate end-points. With the present method one may define the activity of receptor-destroying enzyme precisely in turbidity-reducing units per unit weight, as is done with hyaluronidase, and the same holds for purified virus. The accuracy and reproducibility of the method make it particularly suitable for physical studies of viral and bacterial receptor enzymes to be described elsewhere[9].

The turbidity-reducing phenomenon also throws light on the nature of the interaction between viral enzymes and their mucoprotein substrates. Gottschalk and his collaborators[10] have shown that an N-substituted fructosamine (*iso*glucosamine) is liberated as an end-product of the interaction between influenza virus and partly purified mucoprotein substrates. The turbidity-reducing action of *MEL* and *WS* viruses suggests that, as with hyaluronidase, the initial attack on the substrate is a depolymerization which precedes the liberation of substances reacting with Ehrlich's reagent. Finally, the turbidity-reducing reaction provides truly *in vitro* evidence of the reality of enzymic action by influenza virus.

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Hæmagglutinin Anti-*N* in Plant Seeds

Some plant seeds contain specific antibodies for the antigens *A*, *B* and *O* (or *H*) of human blood[1,2]. *Rh*, *M* and *N* antibodies have been sought, but with negative results[2]. Through the courtesy of Prof. K. Mohrdiek (Porto Alegre), we received seeds of four species of *Vicia* from southern Brazil. Seed extracts were made and tested in the usual manner[1], except that the blood cells were washed once and readings made with a hand lens. The seeds of one species were found to contain anti-*N*.

The freshly prepared extract of *Vicia graminea* agglutinated *N* or *MN* cells, the titre being 32 to 64 after one hour at 4°, 20° or 37° C. The extract diluted 1 : 4 left as a rule suspensions of *N* cells unaltered after one hour, although some *M* samples did react. The same dilution of the extract agglutinated after half an hour, of a total of twenty-five samples, all the twelve *N*-positive and none of the thirteen *N*-negative ones. This would demonstrate that the antibody of the extract is anti-*N* if we were dealing with an independent antigen – antibody system. Generally, however, *N* occurs more often with *s* than with *S*. To exclude anti-*s* we made use of anti-*S*, since we had no anti-*s*; and some *S*-negative, hence *s*-positive, samples gave negative reactions with the extract 1 : 4 after half an hour. Under the same conditions eighty-three random blood samples were examined, fifty-seven of which gave positive and twenty-six (or 31 per cent) negative reactions with the extract, in agreement with the frequency (30·6 per cent) of type *M* in São Paulo[3,4]. Among those eighty-three reactions only one was doubtful, and the respective sample was shown to be *MN* with unusually weak *N*. In conclusion, the extract of *Vicia graminea* contains *N* antibody of an activity and specificity not much inferior to those of the animal anti-*N* sera in use.

As to the other seeds, the extract of *Vicia linearifolia* failed to agglutinate human blood even after three hours. In the seeds of *Vicia sativa* and *Vicia benghalensis* strong agglutinins were present but without distinct specificity for *A*, *B*, *O*, *M*, *N*, *S*, *P*, *C*, *D*, *E*, *c*, *d*, *e*, *Lu*, *Le*^{a}, *K* or *Fy*^{a}.

Yet, since one among four species of *Vicia* displayed specific hæmagglutinin not related to the *ABO* system, it seems probable that the screening of such extracts with a large panel of blood cells might lead to the discovery of more specimens of *N* antibody and even of hæmagglutinins of other specificity.

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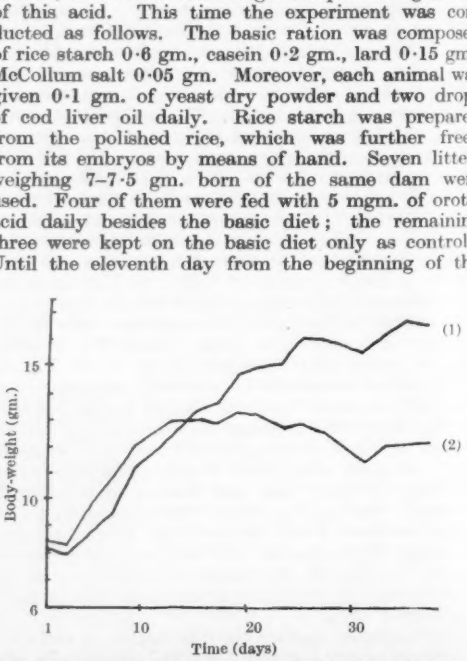
Orotic Acid as One of the Growth-factors of Mice

In 1946 it was shown in our laboratory[1] that orotic acid causes an increase in the reticulocytes in circulating blood, but its action in increasing the body-weight of albino rats by administering orotic acid to animals fed on a basic diet was not made clear. This was attributed to the fact that the basic ration was inadequate. Three years ago we conducted feeding experiments, again with mice instead of rats, and confirmed the growth-promoting action of this acid. This time the experiment was conducted as follows. The basic ration was composed of rice starch 0·6 gm., casein 0·2 gm., lard 0·15 gm., McCollum salt 0·05 gm. Moreover, each animal was given 0·1 gm. of yeast dry powder and two drops of cod liver oil daily. Rice starch was prepared from the polished rice, which was further freed from its embryos by means of hand. Seven litters weighing 7–7·5 gm. born of the same dam were used. Four of them were fed with 5 mgm. of orotic acid daily besides the basic diet; the remaining three were kept on the basic diet only as controls. Until the eleventh day from the beginning of the



Mean values of body-weight of mice: (1) fed with orotic acid; (2) controls

feeding experiment, no difference between the experimental group and control appeared; but after that increase of body-weight in the latter group ceased or became slowed down considerably, thus contrasting remarkably with that of the experimental group the body-weights of which increased considerably (see accompanying graph).

As cow's milk contains a considerable amount of orotic acid, it is possible that the remarkable increase of body-weight in the calf may be attributed partially to the existence of this acid in cow's milk. (Formerly it was suggested[1] that orotic acid may have some promoting action upon the lactation of certain animals.)

From the above result, orotic acid might be reckoned among growth-factors essential for mice, and presumably also for other animals.

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Experimental Production of Hepatic Necrosis and Fibrosis with Water

IN the course of experiments devised to study the effects of the parenteral administration of various types of fluids on lymph-flow in the rat, I had occasion to introduce sterile distilled water intravenously by way of the portal vein. As a result of this procedure, observations were made on the production of acute hepatic injury followed by fibrosis.

Normal adult male rats of the Long–Evans strain, unfasted, were anæsthetized with ether. Through a 3-cm. ventral midline abdominal incision, and using appropriate retraction, the duodenum was displaced caudally in such a manner as to expose the portal vein. Using a No. 27 hypodermic needle, 20 ml. (about 5 per cent of the body-weight) of sterile distilled water prepared for parenteral use was injected over a 5–10 min. period. The rate of injection was carefully regulated to prevent undue distension of the portal vein or the production of back pressure in the portal tract. The site of injection was generally at the junction of the splenic and superior mesenteric vein. Since the vein is quite thin, care must be exercised in the technique of injection, else severe hæmorrhage will ensue, in the event of slight tearing or undue distension of the vein. The incision was repaired, and the animals were allowed access to food and water. For study of liver tissue, biopsy specimens were taken before injection, 5–10 minutes after injection, and at intervals of 1–2 weeks. Tissues were fixed in Bouin's or 10 per cent formalin. Frozen sections were stained with sudan IV and hæmatoxylin; other sections prepared by the nitrocellulose technique were stained with hæmatoxylin and eosin. Appropriate controls were studied, using equal amounts of 0·9 per cent sodium chloride solution. All solutions were injected at room temperature.

The slow injection of water into the portal vein as described above produced a generalized mild blanching of the liver after the introduction of 2–4 ml. of fluid. This blanching was maintained for the period of injection, scattered lobular areas becoming more markedly pale. On cessation of the injection, the liver slowly regained its normal colour, save for the scattered pale areas noted during injection. Blanching and subsequent injury did not occur after similar portal injection of 0·9 per cent sodium chloride solution, or after injections of water were introduced into a systemic vein (external jugular).

Study of the changes occurring in the liver within 10 min. after portal vein injection were made on sudan-stained frozen sections. Comparison of the pre-injection biopsy specimen with the injected specimen revealed increases in histologically visible parenchymal, finely granular fat with some evidence of scattered lipid vacuole formation. The most prominent changes, however, were noted in the immediate widespread evidence of centro-lobular non-lipid cellular vacuolation, with evidence of parenchymal swelling. Upon autopsy after an interval of 3–5 days, irregular and variable gross scarring of the liver surface was noted. Sections of the involved areas revealed areas of complete parenchymal necrosis. Scattered in these areas of necrosis and fibrosis, and in relationship to the portal triad, were noted areas of active regeneration, evidence of hepato-cellular loading with fine and globular fat in these cells being marked. Certain of the degenerative areas exhibited evidence of anæmic infarction, and some hæmorrhagic areas were noted, but no gross thrombi were seen. Repetition of the injection of water into the portal vein of individual animals after intervals of 4–6 weeks produced a more marked and diffuse type of gross scarring. Animals treated in the manner described did not exhibit gross evidence of jaundice. No convulsions or evidence of water intoxication were noted. Hæmoglobinuria was evident for the first few days.

The list of agents known to cause experimental and clinical hepatic injury is long. The nature or mode of action of these agents has been extensively studied in the experimental and clinical laboratory. The pathogenesis involved has been summarized and described by various authors[1–3]. The present experiments add water to this list of hepatotoxic agents as a necrotizing and cirrhogenic agent. The similarity of the lesions produced by water to those produced by other necrotizing chemical agents suggests, however, that alteration of cellular permeability to water may be a common property of many of these agents[3].

Of importance is the implication from the present experiments that alterations in osmotic and electrolyte equilibrium may be an immediate factor in the causation of hepatocellular injury. In 1935, Selye, Collip and Thomson[4] demonstrated that the systemic intravenous administration of isotonic saline solution would, under certain conditions, produce fatty liver and ascites in the rat, and Moller-Christensen[5] has recently summarized his own and previous evidence showing liver injury occurring in the production of an eclampsia-like symptom-complex, produced in the rat by oral administration of water and injection of vasopressin. Generally, however, but meagre attention has been paid to the potential role of water and electrolyte disturbances in the production of liver damage and disease. Although no immediate parallel to the present experiment is found under natural conditions (cf. intravenous injection of fluids in the anæsthetized state), it must, however, be suggested that alterations in absorption of water and/or electrolytes may be of great importance in eliciting hepatic parenchymal damage and that attention must be paid

to the role of various components of the diet, that is, protein, fat, carbohydrate, various lipotropic substances, vitamins and electrolytes, in altering water absorption. The implication, of course, is that the products of gastro-intestinal absorption may be altered in such a way as to present an abnormal circulating medium to the liver cells.

The present experiments provide a rapid method for the production of liver damage which may be of value in the evaluation of the relative significance of various dietary components, lipotropic, carcinogenic, cirrhogenic and hormonal agents, as related to the prevention and treatment of liver injury.

This work was assisted by a grant from the National Institutes of Health, United States Public Health Service.

Acknowledgment is made for the provision of assistance by Prof. C. H. Li and Dr. H. M. Evans. The participation in phases of this work of J. Schooley and R. Kenigsberg is greatly appreciated.

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Reducing Substances in *Zostera*

During a study of the reduction of sulphates in *Zostera* mud flats, it was found that when autoclaved *Zostera* was added to autoclaved sand and sea water, ferrous sulphide was rapidly produced. At first it was thought that this reduction was microbiological, but later it was found that living *Zostera* could bring about the reduction. A study of *Zostera* showed that a lead mirror could be produced from lead acetate by heating this substance with *Zostera* leaves and that this mirror was intracellular in the leaf parenchyma. When washed *Zostera* leaves are heated with distilled water, cadmium acetate papers show yellow cadmium sulphide, and, at times, metallic cadmium. If the distillation is carried out under nitrogen, the steam distillate condensed into 100 ml. of *N*/1,000 hydrochloric acid at *p*H 3·35 yields a nitrogenous solution containing up to 6·75 mgm. nitrogen per litre, and the *p*H rises to 7·0 with a volume increase to 450 ml. In addition, there is a volatile sulphur-containing substance which is soluble in alcohol and produces lead sulphide from lead acetate. This sulphur compound gives no precipitate with mercuric chloride and a white precipitate with alcoholic lead acetate, suggesting a thioether. It has an unpleasant odour. The production of lead sulphide from lead acetate seems to depend on a partial volatilization of the nitrogenous base. *Posidonia* appears to contain a different sulphur derivative with a more pungent odour.

Both these substances are present in small amounts and their relative proportions in the plant seem to vary considerably. During October–November, little of the sulphur compound was present in *Zostera*; but after flowering in January, the sulphur compound increased while the nitrogenous base disappeared. The latter was still present, however, in *Zostera* from a bed that was not flowering. These substances are possibly united in the plant with a redox pigment, probably of a dapside glucoside nature.

The existence of these two substances may be of great importance in *Zostera* muds in two ways: they may produce ferrous sulphide directly, and may also bring about reducing conditions that greatly accelerate sulphate reduction by *Microspira*.

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Action of Insecticides on a Stem Borer of Oats: the Frit Fly

In an attempt to assess the possibility of controlling gramineaceous stem borers by systemic and seed-dressing insecticides, the following results were obtained in laboratory and field experiments with larvæ of flies of the 'frit' complex, *Oscinella frit*.

Initial tests of the toxicity of 'Pestox 14' or *bis* dimethylamino-fluorophosphine oxide (Pest Control, Ltd.) to larvæ immersed in aqueous solutions of different strengths showed 71 per cent mortality with 0·0005 per cent and 100 per cent with 0·005 per cent after three days. There was apparently no difference in toxicity to different instars.

Percentage Mortality to Mixed Instar Larvæ of Solutions of 'Pestox 14'

Strength of solution (per cent)	Time of immersion		
	6 hr. (per cent)	24 hr. (per cent)	3 days (per cent)
0·0005	0	14	71
0·005	0	100	100
0·05	59	100	100
0·5	100	100	100
Water	0	0	0

'Pestox 14' caused shrivelling of the larvæ proportional to the concentration and probably due to osmotic dehydration. This effect differs from the turgidity observed in death from parathion.

That translocation of systemic insecticides can occur in members of the Gramineæ is supported by work on the wheat bulb fly (*Hylemyia coarctata*) by Pest Control, Ltd., by the Overseas Food Corporation on sorghum central shoot borer (*Atherigona indica fuscata*), by Questell and Conin[1] on the toxicity of maize tissue to European corn borer (*Pyrausta nubilalis*), and by death of aphids on young oats grown in pots and watered with 0·05 per cent 'Pestox 3' (octamethylpyrophosphoramide or 'Schradan') after twenty-four hours during the present experiments.

Individual oat seedlings grown in Pfeffer's solution and infected with larvæ in the laboratory were used to demonstrate that 0·1 per cent 'Pestox 3' and 0·1 per cent 'Pestox 14' killed all larval stages in the stems in two to three days after the insecticides were introduced into the culture solutions. With potted seedlings grown in soil, however, watered with 'Pestox 3' at rates to give 50, 180 and 300 parts per million of soil, no dead larvæ could be found and progressively fewer live larvæ remained in the plants down to none at the 180 p.p.m. level, suggesting a specific repellant action on the larvæ.

In the field, counts of infested tillers in plots of 6 sq. ft. showed that, at a rate equivalent to 200 gallons per acre, 'Pestox 3' at 0·5 per cent killed 66 per cent, and at 1 per cent killed 75 per cent of the larvæ present, while 'Pestox 14' and parathion, both at 0·5 per cent, killed 20 per cent and 100 per cent respectively at 4 days after spraying. None of these treatments was phytotoxic at these concentrations although 'Pestox 3' has since been found to be the least phytotoxic. It is of interest that Schrader[2] found parathion to be effective against *Chortophila* and *Contarinia* at 0·01 per cent.

There was evidence of superior growth after treatment with 0·1 per cent 'Pestox 14' and 0·5 per cent parathion, observed by Chao-Seng Tsi[3]; but subsequent equalization takes place and final yields were not statistically different.

Seed dressing with gamma benzene hexachloride dressings ('Mergamma *A*', Plant Protection, Ltd.) at the recommended rate of 2 oz./bushel reduced the dead-heart rate from 61 to 48 per cent and also markedly stimulated growth. Heavier doses of benzene hexachloride soil-type insecticides as seed dressings and soil dressings also reduced frit attack but tended to be phytotoxic at the levels used.

Preliminary experiments of soaking seeds in systemic insecticides, reported to be effective with beans by Chao-Seng Tsi[3], indicated that soaking in 0·5 per cent 'Pestox 3' was not phytotoxic and that 17 hr. was the most effective time for absorption.

The above was part of a thesis submitted while studying under a Colonial Insecticide Studentship at the Imperial College Field Station, Silwood Park, Ascot, Berkshire. Acknowledgment is due to Dr. W. F. Jepson and other members of the staff for help and advice.

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Boiling Point of Capillary-condensed Water

A considerable amount of experimental work on freezing-point depressions of capillary condensates has been reported in the literature in recent years[1]. Carman[2] has given an account of a few more properties in which capillary-held liquids differ from the same materials in bulk conditions. Boiling points of condensates, however, do not appear to have been studied in detail. We have devised a simple method for this purpose. The apparatus, in its essentials, consists of a small vessel, which contains the capillary system under examination; it is connected to a vacuum pump as well as to a suitable differential manometer and is placed in an oil-bath, the temperature of which can be gradually raised. The vessel is first evacuated, and the manometer then registers the vapour pressure of the liquid under examination. The temperature of the bath is then gradually raised until the vapour pressure becomes equal to the atmospheric pressure. The temperature recorded then is the required boiling point.

Boiling points of water held at different vapour pressures in four different porous bodies (silica gel, sugar, charcoal, a sample of bentonite and a sample of clay loam), varying largely in their pore size-distribution relationships, were determined by means of this technique. The results showed that, for a given capillary radius, boiling-point elevation is about the same, irrespective of the nature of the adsorbent or the amount of the liquid contained in it.

The boiling-point elevations of water (average values for the four adsorbents) condensed in pores of radii less than 1060, 102, 30, 15·5 and 9 A. were found to be 2·4°, 4·9°, 12·6°, 21·2° and 34·1° C. respectively. These values agree well with the theoretical values calculated from thermodynamic considerations based on the theory of capillary condensation.

A detailed account of this work will be published elsewhere.

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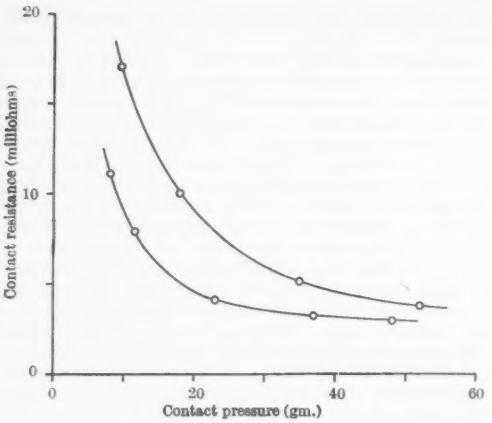
Electrical Contact Resistance between Magnetically Attracted Bodies

In the course of work upon the characteristics of light-current contacts, the electrical resistance between contact-making members of magnetic material drawn together magnetically has been compared with that between the same members pressed together by an external force.

In both cases individual measurements for the same contacts at the same mechanical pressure vary considerably; but in all the experiments so far completed the average contact resistance over a large number of trials has been less—sometimes substantially less—when the pressure has been applied magnetically.

The accompanying curves show the variation in contact resistance with contact pressure for a contact comprising a nickel block and the tip of a thin nickel-plated steel strip. In the upper curve the pressure was applied gravitationally after demagnetization of the specimens, and in the lower (apart from about 1 gm. due to the weight of the steel strip) by magnetic attraction. In both cases the pressure was measured by means of a counterweight arranged to separate the contact members. The gross contact area was approximately 20 mm.^{2} and the current (constant) was 0·1 amp. The tests were carried out under ordinary room conditions.

Each point on the curves represents the arithmetical mean of eighty measurements. Between each measurement and the next, the tip of the steel strip was given a slight lateral displacement by sliding it on the nickel block. The current was cut off during this operation; but the contact pressure was maintained. Magnetic and gravitational measurements were made alternately in sets of ten at each contact pressure. Half



the measurements were made with ascending, and half with descending, values of pressure.

The standard errors of the means were as follows, taking the points in order from left to right along each curve:

Gravitational points	0·84	0·70	0·25	0·28	$\Omega \times 10^{-3}$
Magnetic points	0·53	0·36	0·12	0·09	0·15 $\Omega \times 10^{-3}$

More than one factor may contribute to the effect noticed. Apart from any resistance due to surface film, the spreading resistance from an ideal contact spot on a comparatively large contact member is inversely proportional to the radius of the spot[1]. The pressure necessary to produce a spot, on the other hand, increases more rapidly than the radius. Its value depends upon whether the deformation is predominantly elastic or predominantly plastic[2]; but in general it is proportional to at least the square of the radius. Under these conditions, any increase in the number of contact spots for a given total pressure will result in a decrease in the joint resistance of the several spreading resistances in parallel.

Contact members drawn together magnetically seem likely to have more contact spots, and hence a lower contact resistance, than the same members pressed together blindly by an external force, since in the magnetic case an increase in the force will tend to form new spots by drawing together points almost but not quite touching, rather than merely to increase the size of existing spots. Magnetic saturation will no doubt occur at established spots; but this will promote rather than hinder the formation of new spots elsewhere.

Again, an external force may be partly wasted upon particles of insulating (and therefore non-magnetic) matter between the surfaces, whereas the magnetic force would tend to be concentrated in the vicinity of magnetic (and therefore conducting) protuberances. Tests with partially contaminated contacts have yielded gravitational and magnetic curves much more widely separated than those in the graph.

If, instead of plotting contact resistance against contact pressure, we plot it against the lateral force necessary to overcome the static friction between the contact surfaces, the difference between the two curves appears in general to be still present, although less marked.

It is thought that the effect described may have useful applications[3] in the field of light-current contacts, and also that it may repay investigation by those interested primarily in the frictional characteristics of sliding surfaces.

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Elastic Deformation and the Contact of Surfaces

The friction, wear and electrical contact resistance of surfaces in stationary or sliding contact have been interpreted in terms of the real area of contact between the surfaces formed by the deformation of the material in the regions where they touch[1]. In general, it is to be expected that the total real area of contact will be divided between a number of individual areas. Recently, the implications of such multiple-contact conditions have been considered by using simple models to represent the contacting surfaces. In this way Lincoln[2] has attempted to explain the variation with load of the friction of high polymers, and I have discussed the contact resistance and wear of nominally mating surfaces[3]. It is the purpose of the present communication to emphasize the physical concepts which are inherent in these treatments and to indicate some general considerations which are independent of the particular model used.

As in the work described by Lincoln, it will be assumed that the deformation is entirely elastic; but plastic deformation can be considered by similar methods. For a single contact, the area of contact is proportional to the two-thirds power of the load. For multiple-contact areas the physically important postulate is the assumed variation of the number and size of the individual areas with load. As extreme cases, one can assume that either the number or the average size of these contact areas remains constant. Unless physically unlikely assumptions are made, in the former the area of contact is again proportional to the two-thirds power of the load, and in the latter the area is proportional to the load. If (as in the models mentioned above) an increase in the load causes an increase in both the number and size of the individual contact areas, the method of dimensions shows that the total contact area A is related to the load P by a general equation of the form,

$$A = K(P/E)^n. \qquad (1)$$

E is the Young's modulus of the material of the two surfaces (assumed similar) in contact, and K is a constant depending on the model used; it must, however, have dimensions of $(\text{length})^{(2-2n)}$. n, which also depends on the model, lies between 2/3 and unity and has values of 8/9 and 4/5 in Lincoln's model and my model respectively. It is unlikely that existing experimental evidence is sufficient to distinguish between these two and other possible models. However, this evidence (for example, of the friction of high polymers and of the contact resistance of flat metallic surfaces) does suggest that the effective area of contact is related to the load by a more general equation, such as (1) above, with values of n between 2/3 and unity. Hitherto these values of n have usually been taken to indicate a departure from elastic conditions. The common aim in the use of

multiple contact models is to show that such values of n are perhaps explainable, in terms of a distributed contact area and load, without postulating a change in the mechanism of deformation.

J. F. Archard

Research Laboratory,
Associated Electrical Industries, Ltd.,
Aldermaston, Berkshire. Sept. 21.

[1] Holm, R., "Electrical Contacts" (H. Gerbers, Uppsala, 1946). Bowden, F. P., and Tabor, D., "The Friction and Lubrication of Solids" (Oxf. Univ. Press, London, 1950).
[2] Lincoln, B., *Nature*, **172**, 169 (1953).
[3] Archard, J. F., *Research*, **5**, 395 (1952); **6**, 33S (1953); *J. App. Phys.*, **24**, 981 (1953).

An Approach to Palæometeorology

Geological data have long been employed in reconstructing climates of the remote past, while palæobotanists in particular have demonstrated the temperature conditions of certain areas at selected periods. Much of the more precise botanical and palæontological evidence relates to glacial and post-glacial times, for which successions of wetter and dryer and of cooler and warmer climates were well established. Recent work now suggests that it may be possible to indicate, for portions at least of the Pleistocene of north-west Europe and some other areas, the approximate intensity of rainfall, that is, rate of rainfall per unit of time, which characterized certain climatic episodes. Thus light is thrown on weather, as opposed to climate, in the geological past. It may be possible in due course to bring these studies into relation with theoretical discussions of cyclonic activity during the Pleistocene.

The new information comes from investigations of meandering valleys, that is, valleys which describe systematic curves far larger than the loops of the rivers which flow in them. The many hypotheses of the origin of meandering valleys cannot be discussed here, but it can be said that a number have ascribed them to powerful ancestral streams. Their features reproduce, on a large scale, those of an incised meandering stream-course.

The resemblance is now known to extend beyond the forms visible at the surface to those concealed beneath the flood-plain alluvium. Six valleys have so far been studied in detail. In each, the alluvium is contained in a large channel, which winds around the valley bends and has a bed-form appropriate to a meandering stream. The ratio of bed-widths between filled and present channels is of the order of 10 : 1.

Although much remains to be discovered about the ultimate cause of meandering, laboratory studies and measurement of natural streams combine to indicate that dimensions of meanders are related principally to stream discharge[1]. It seems reasonable to conclude, therefore, that the filled channels are the beds of large streams which eroded the valley bends, and which discharged much more water than the present streams, stage for stage.

As a first approximation, the discharge required to nourish streams capable of cutting the filled channels may be found from Lacey's well-known equation[2]:

$$P = 2{\cdot}67Q^{1/2},$$

where P is the wetted perimeter in feet and Q the discharge in cusecs. (It is realized that this equation raises a number of problems, but there seem good reasons for accepting it in the present connexion.) At the rates calculated, the whole of the present rainfall could be run-off, without loss, in some five days.

The order of rainfall intensity required to provide the calculated discharges, with the channels flowing at bankful, may be derived from the 'rational formula' of flood discharge:

$$Q_{\max.} = 640\,CiM,$$

where C is a coefficient of run-off, i the rainfall intensity in in./hr., and M the catchment area in square miles. This equation is suitable for use only with small catchments, and gives high discharge values.

Assuming maximum and very rapid run-off, C becomes unity. The two equations may now be combined in the form

$$i = \frac{P^2}{4550\,M},$$

which gives the former rate of discharge (in terms of rainfall intensity) corresponding to a given size of channel and area of catchment. In the six basins investigated, calculated values of i range from 0·21 to 0·33 in./hr.

At the present day, falls of this order are likely to occur over limited areas on two to ten days a year. But since meandering valleys are widespread, for example, in southern England and France, they would appear formerly to have been common and extensive.

Superficial deposits provide the chief means of dating the filled channels and the rivers which once occupied them. Some meandering valleys date back well into the Pleistocene; but the actual channels studied are all later than the last local glaciation, where they lie within the extreme limits of ice. Fossils from the alluvial fill have been identified as of extant species; the deposits are not promising material for pollen analysis. Converging evidence of an indirect or inferential kind suggests that some at least of the channels were still occupied by large rivers as late as the assumed end of the Pleistocene, that is, 10,000 years ago.

G. H. Dury

Department of Geography,
Birkbeck College
(University of London),
London, W.C.1.
Aug. 6.

[1] Inglis, Sir C., Res. Pub. No. 4, Cent. Irrigation and Hydrodynamic Res. Stat., Poona (1941). Fisk, H. N., U.S. War Dept., Mississippi River Commission (1944). Friedkin, J. F., U.S. War Dept., Waterways Experiment Stat. (1945). Quraishy, M. S., Ph.D. thesis, London (1942).
[2] Lacey, J. M., *Min. Proc. Inst. Civ. Eng.*, **229**, 259 (1930).

Young Morainic Topography in Holderness

In 1951, A. Farrington and G. F. Mitchell published their observations during a visit to the glacial drifts of eastern England[1]. In their own words, they had "spent several days in the district mapping in outline the young topography north of Flamborough Head. . . . Beacon Hill and the mounds in Holderness at Kelk, North Frodingham and Brandesburton were also examined. . . . The authors have not seen any young morainic topography on the east coast of England south of Flamborough Head".

During spring–autumn of 1952, I carried out a geomorphological investigation of Holderness and adjacent parts of east Yorkshire and north-east

Lincolnshire. Eight recessional stages of the ice front could be established, starting with the marginal drainage channels in the Yorkshire and Lincolnshire Wolds, which had already been partially described by G. de Boer[2]. The glacial relief of western Holderness was found to be very mature indeed. A more conspicuous end-moraine, though still with a rather smooth surface, was traced from Haisthorpe via Kelk, North Frodingham, Routh and Wawne to Sutton, with corresponding esker systems near Kelk and Brigham-Brandesburton. A very different young morainic topography occurs, however, to the east of a line from Ulrome via Brandesburton, Skirlaugh, Preston, and Keyingham to Easington. Here are two high end-moraine ridges, one passing through Bewholme, Rise, Sproatley, Keyingham and Dimlington, and the other following the coast from Atwick via Mappleton, Grimston, Patrington to Holmpton, both with many kettle-holes filled with post-glacial lacustrine deposits not covered by solifluxion material. The ridges are traversed in the east–west and north-east–south-west direction by subglacial valleys, the best developed of which is the valley of Hornsea, with the "Rinnensee" of Hornsea Mere and the corresponding outwash fan of Leven still preserved.

Comparing all these features with the young morainic topography in north-east Germany, I am convinced that the last glaciation (Würm–Weichsel–Wisconsin) did not stop north of Flamborough Head, but extended with an ice lobe to eastern Holderness. The full results of the investigation will be published shortly.

Hartmut Valentin

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der Freien Universität Berlin,
Berlin-Lichterfelde-West,
Potsdamer Str. 11.

[1] *Proc. Geol. Assoc.*, **62**, 100 (1951).
[2] *Proc. Yorks. Geol. Soc.*, **25**, 223 (1945).

Wilberforce and Huxley on Evolution

It was a famous moment in the history of science when, during the discussion of Darwin's theory of evolution at the British Association meeting at Oxford in 1860, Bishop Wilberforce turned to T. H. Huxley and asked him whether he claimed descent from an ape on his father's or his mother's side.

The actual words of Huxley's reply are not known; in the excitement, members of the audience noted different points, and two or three versions appear in the biographies and histories. The main source of our information, his son Leonard Huxley, wrote "most unluckily, no contemporary account of his own exists of the encounter"[1].

Such an account does, however, exist in a letter written to Dr. Dyster within a few months of the meeting, on September 9, 1860, and now preserved in the collection of Huxley Papers at the Imperial College of Science and Technology, London. The style of the quotation has the authentic tone: the putting his opponent in the wrong from the start, the use of antithesis, the long complex build-up to a dramatic pause, and then the final swift and decisive swoop. Considering also the accuracy with which Huxley was able to recall the details of what he had once formulated in his mind, it seems likely that this letter contains as nearly correct a record as we shall ever possess.

"When I got up I spoke pretty much to the effect—that I had listened with great attention to the Lord Bishop's speech but had been unable to discover either a new fact or a new argument in it—except indeed the question raised as to my personal predilections in the matter of ancestry—That it would not have occurred to me to bring forward such a topic as that for discussion myself, but that I was quite ready to meet the Right Rev. prelate even on that ground. If then, said I, the question is put to me would I rather have a miserable ape for a grandfather or a man highly endowed by nature and possessing great means and influence and yet who employs those faculties and that influence for the mere purpose of introducing ridicule into a grave scientific discussion—I unhesitatingly affirm my preference for the ape.

"Whereupon there was unextinguishable laughter among the people, and they listened to the rest of my argument with the greatest attention . . . I happened to be in very good condition and said my say with perfect good temper and politeness—I assure you of this because all sorts of reports [have] been spread about e.g. that I had said I would rather be an ape than a bishop, etc."[2].

I am indebted to the Governors of the Imperial College for permission to publish this extract.

D. J. Foskett

The Metal Box Co., Ltd.,
Research Division,
Acton, W.3.

[1] Huxley, Leonard, "The Life and Letters of T. H. Huxley", 1, 259 (Macmillan, 1903).
[2] Imperial College, "The Huxley Papers", **15**, 117–118.

Early Record of Temperature-Control in Distillation

We have recently published a study[1] of Johannes Banfi Hunyades (1576–1650), a Hungarian who about 1645 was professor of hermetic philosophy and mathematics at Gresham College, London.

MS. Sloane 1139 (British Museum), much of which was written by Jonathan Goddard, Gresham professor of physic from 1655, gives an account of the process adopted by Hunyades for distilling oil of amber. It contains the observations:

f.16r. "We observed yt in strong boyling to destill at the first in the 20 degree and at the last in the 40 degree."

f.18r. "dom Hunniades destilled it in the 6 and 4 degree."

These statements appear to constitute the earliest record of temperature measurement in distillation: we at any rate cannot interpret them in any other way. Hunyades died in 1650, and his process is likely to date from a period some years earlier. How, then, did he measure the temperature? Scarcely, we would think, with an air-thermometer of the types recorded by Galileo, Sanctorius or Fludd. Are we to suppose that he had a sealed thermometer of the type made for Ferdinand II, Duke of Tuscany, in 1641?

F. Sherwood Taylor

Science Museum,
London, S.W.7.

C. H. Josten

Museum of the History of Science,
Oxford. Aug. 5.

[1] *Ambix*, **5**, 44 (1953).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 16

INSTITUTE OF METAL FINISHING (at Burlington House, Piccadilly, London, W.1), at 6 p.m.—Demonstration of Research and Control Technique in Electrodeposition.

Tuesday, November 17

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (joint meeting with the CROP PROTECTION PANEL, in the Chemistry Lecture Theatre, Royal College of Science, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Symposium on "Grassland Management" and "The Treatment of Turf".

BEDFORD COLLEGE (at Regent's Park, London, N.W.1), at 5.15 p.m.—Prof. C. Daryll Forde: "Development of the Native Culture of West Africa" (Stevenson Lecture).*

CHADWICK PUBLIC LECTURE (at the Royal Sanitary Institute, 90 Buckingham Palace Road, London, S.W.1), at 5.30 p.m.—Dr. John A. Logan, in collaboration with Dr. R. P. Burden: "The Public Health Significance of Environmental Control by Engineering Means".*

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at 47 Belgrave Square, London, S.W.1) at 5.30 p.m.—Dr. A. S. Baxter: "Electron Multipliers".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. A. H. M. Arnold: "Alternating-Current-Instrument Testing Equipment".

PHYSICAL SOCIETY, LOW TEMPERATURE GROUP (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. R. Kekwick and Dr. R. Strickland-Constable: "Freeze Drying".

BRITISH ORNITHOLOGISTS' UNION (in the Lecture Hall, British Museum (Natural History), Cromwell Road, London, S.W.7), at 6 p.m.—Annual Scientific Meeting. Mr. Peter Scott: "Ornithological Results of a Journey to Tierra del Fuego and the High Andes", followed by a film on the Bird Life of Patagonia.

ROYAL INSTITUTE OF CHEMISTRY (joint meeting with the BATTERSEA POLYTECHNIC CHEMICAL SOCIETY, at the Battersea Polytechnic, London, S.W.11), at 7 p.m.—Mr. W. S. Wood: "The Manufacture and Uses of Hydrogen Peroxide".

Wednesday, November 18

POSTGRADUATE MEDICAL SCHOOL OF LONDON (at Ducane Road, Shepherd's Bush, London, W.12), at 2 p.m.—Prof. F. G. Young, F.R.S.: "Some Aspects of the Endocrine Control of Carbohydrate Metabolism".* (Further Lecture on November 19.)

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, South Kensington, London, S.W.7), at 5 p.m.—Scientific Papers.

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. P. T. Bauer: "Statistics of Statutory Marketing in West Africa, 1939–51".

EUGENICS SOCIETY (at the Rooms of the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. G. Aird Whyte and Dr. C. P. Blacker: "Possible Future Activities of the Eugenics Society".*

ROYAL MICROSCOPICAL SOCIETY (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Prof. F. W. Jane: "The Frontiers of the Plant and Animal Kingdoms".*

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (at King's College, Strand, London, W.C.2), at 6.30 p.m.—Annual General Meeting.

Thursday, November 19

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. W. B. Emery: "Excavations at Sakkara (Egypt) in 1953".*

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. R. Berman, Prof. F. E. Simon, F.R.S., and Mr. J. M. Ziman: "The Thermal Conductivity of Diamond at Low Temperatures"; Mr. F. C. Champion: "Variations in the Texture of Diamonds".

INSTITUTION OF MINING AND METALLURGY (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. W. R. Cheetham and Mr. E. W. Inett: "Factors Affecting the Performance of Percussive Drills"; Mr. D. C. J. Squirrell: "Surface Diamond Drilling Problems and Practice in the Copperbelt Area of Northern Rhodesia".

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. N. Woodhead and Mr. R. D. Tweed: "A Consideration of the Freshwater Algae of Sierra Leone"; Mr. G. Owen Evans: "An Introduction to the External Morphology and Biology of the British Pseudoscorpiones (Arachnida)".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Annual General Meeting. Prof. W. W. Rogosinski: "Extremum Problems for Real Polynomials and Trigonometrical Polynomials".

INSTITUTION OF ELECTRICAL ENGINEERS, UTILIZATION SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. R. F. Sims: "The Wear of Carbon Brushes at High Altitudes".

RESEARCH DEFENCE SOCIETY (in the Physiology Lecture Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. Sir James Learmonth: "The Surgeon's Debt to Animal Experiment". (Twenty-Second Stephen Paget Memorial Lecture.)

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS GROUP (at the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6 p.m.—Mr. E. H. Nevard: "Reasons and Methods for Timber Preservation".

ROYAL AERONAUTICAL SOCIETY (in the Library, 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. A. W. Babister: "Aircraft Stability and Control".

CHEMICAL SOCIETY (in the Lecture Theatre, Institution of Civil Engineers, Great George Street, London, S.W.1), at 7.30 p.m.—Prof. A. Tiselius (Uppsala): "Some Applications of the Separation of Large Molecules and Colloidal Particles" (Centenary Lecture).

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 7.30 p.m.—Laboratory Meeting; Chairman: Dr. Norman White.

BRITISH INSTITUTE OF RADIOLOGY, incorporated with the RÖNTGEN SOCIETY (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 8 p.m.—Dr. Sheila T. Callender and Dr. John Badenoch: "The Use of Radioactive Iron in the Investigation of Anæmia"; Dr. E. H. Belcher, Mr. I. G. F. Gilbert and Dr. L. F. Lamerton: "Experimental Studies with Radioactive Iron".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, BIOLOGICAL METHODS GROUP (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 8 p.m.—Dr. Chester I. Bliss (U.S.A.): "The Standardization of a Drug in Production as Illustrated by Adrenal Cortical Extract".

Friday, November 20

PHYSICAL SOCIETY (at the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Prof. W. Sucksmith: "Some Magnetic Measurements—Techniques and Applications"; Prof. F. C. Williams: "Cathode-Ray Tube Storage for Digital Computers".*

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Sir Richard Southwell, F.R.S.: "Relaxation Methods: a Retrospect" (Thomas Hawksley Lecture).

INSTITUTE OF PHYSICS, INDUSTRIAL RADIOLOGY GROUP (at 47 Belgrave Square, London, S.W.1), at 6.30 p.m.—Mr. R. Meakin: "Scattered Radiation".

ROYAL HOLLOWAY COLLEGE (at Englefield Green, Egham, Surrey), at 8.15 p.m.—Mr. F. I. G. Rawlins: "The Work of the Scientific Department of the National Gallery".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. Kenneth P. Oakley: "Dawn of Man in South Africa".

Friday, November 20—Saturday, November 21

INSTITUTE OF PHYSICS, X-RAY ANALYSIS GROUP (at the Institution of Electrical Engineers, Savoy Place, London, W.C.2).—Autumn Conference.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

CHEMIST (with university degree or equivalent in chemistry, and experience in some branch of industrial chemistry) in the Divisional Analytical Laboratory, Birmingham and District Division—The Divisional General Manager, West Midlands Gas Board, Gas Offices, Edmund Street, Birmingham (November 21).

CHIEF ENGINEER TO THE NORTH WESTERN ELECTRICITY BOARD—The Establishment Officer, The North Western Electricity Board, Cheetwood Road, Manchester 8 (November 21).

LECTURER (with university degree or equivalent qualifications, and sound fundamental knowledge of physical chemistry) IN OREDRESSING in the Department of Mining, Metallurgical and Chemical Engineering, South Australian School of Mines and Industries—The Agent-General and Trade Commissioner for South Australia, South Australia House, Marble Arch, London, W.1 (November 21).

FIRST ASSISTANT LABORATORY ENGINEERS (3) (with university degree in civil engineering, physics or chemistry, and corporate members of a recognized professional institution), to take charge of one of the laboratory sub-sections dealing with (*a*) soils mechanics, (*b*) tar, bitumen and coated materials, (*c*) cement and concrete—The County Engineer and Surveyor, County Hall, Wakefield (November 23).

GENERAL MANAGER (with high administrative ability and considerable practical experience of the utilization of fuel and power, and preferably with a recognized technical qualification in the field of combustion and thermal engineering) OF THE NATIONAL INDUSTRIAL FUEL EFFICIENCY SERVICE—The National Industrial Fuel Efficiency Service, Thames House South, 6th Floor, Millbank, London, S.W.1 (November 24).

UNIVERSITY DEMONSTRATOR IN BOTANY, to be responsible for teaching genetics in collaboration with the professor—Prof. C. D. Darlington, The Department of Botany, The University, Oxford (November 24).

PLANT LAYOUT ENGINEER (qualified engineer, with a comprehensive knowledge of the layout of reconditioning workshops and of the plant, machinery, equipment and services connected with them) in the Engineering Branch of the Production Department in London, to assist in the planning and design of a number of modern workshops which are required in the coalfields for the reconditioning of coalmining and other equipment and plant, and for a small amount of specialized manufacture—The National Coal Board, Establishments (Personnel) Hobart House, Grosvenor Place, London, S.W.1, quoting TT/701 (November 27).

RESEARCH ASSISTANT IN PSYCHOLOGY—The Registrar, The University, Manchester (November 28).

SCIENTIFIC OFFICERS (2) (with first- or second-class honours degree in civil engineering) IN THE DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, Road Research Laboratories, Harmondsworth,

West Drayton, Middlesex, for (*a*) research on bituminous road materials and associated machinery, and (*b*) research on soil mechanics and earth moving machinery—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting E.398/53 (November 28).

Assistant in Experimental Pharmacology—The Secretary of University Court, The University, Glasgow (November 30).

Lecturer in Social Anthropology—The Registrar, The University, Manchester 13 (November 30).

Lecturers or Assistant Lecturers (2) in Physics at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (November 30).

Lecturer or Senior Lecturer in Chemical Pathology—The Secretary, Royal Veterinary College and Hospital, Royal College Street, London, N.W.1 (December 1).

Mechanical Engineer (with degree in mechanical engineering or A.M.I.Mech.E.) in the Public Works Department (Development Establishment), Northern Rhodesia, to assist the Senior Mechanical Engineer in the administration of Government Mechanical Workshop Organization—The Director of Recruitment (Colonial Service), Colonial Office, London, S.W.1, quoting CDE.112/3/04 (December 2).

Research Officers (2) (with first-class honours degree, with physics as a major subject or equivalent qualifications, and preferably with research experience in astrophysics or optics) in the Commonwealth Scientific and Industrial Research Organization, Division of Physics, National Standards Laboratory, Chippendale, N.S.W., Australia, to carry out periodical observations at a station to be erected on the Australian Alps—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 770/83 (December 5).

Scientific Officer (with first- or second-class honours degree in natural science with zoology as principal subject, or equivalent qualifications) at the Ministry of Agriculture and Fisheries, Tolworth, Surrey, for research on grey squirrels—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting G.366/53A (December 5).

Research Officer (with at least an honours degree in pure mathematics, and either postgraduate specialist training in mathematical statistics or research experience in applied statistics in the biological or social sciences) in the Mathematical Statistics Section of the National Institute for Personnel Research, Johannesburg—South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (Pretoria, December 7).

Plant Pathologists (graduates from a recognized university with some postgraduate experience and training in plant pathology) with the Tobacco Research Board of Southern Rhodesia—The Director, Tobacco Research Board of Southern Rhodesia, P.O. Box 1909, Salisbury, Southern Rhodesia (December 31).

Lecturer in Pure Mathematics—The Secretary, Queen's University, Belfast (February 15).

Rutherford Scholar (graduate of a university within the British Commonwealth) for research in any branch of the natural sciences, but some preference will be given in favour of candidates who propose to work in experimental physics—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (February 15).

Agricultural Officers (with degree in agriculture and at least two years postgraduate training or experience in agriculture) in the Colonial Territories (at present mainly in East and West Africa and Fiji)—The Director of Recruitment (Colonial Service), Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CDE.68/01.

Botanist (Plant Breeder) (with good honours degree in botany with training in plant breeding, and some knowledge of statistics as applied to field experiments, and at least two years postgraduate experience) at Rokupr Rice Research Station, Sierra Leone—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.87/15/01.

Chemist (with honours degree in chemistry or chemical engineering, or equivalent qualifications) to assist in problems associated with the treatment of radioactive materials, purification of drinking water supplies, general water treatment and general water service—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Berks, quoting 2/103/6.

Civil Engineer (with degree in civil engineering, A.M.I.C.E., A.R.I.C.S., registered architect or equivalent), with the Ministry of Supply at London, S.E.9, to be responsible under direction for preparation of designs, specifications, and estimates for building and civil engineering in explosives and filling factories—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting E.484/53A.

Entomologist (with first- or second-class honours degree in an appropriate subject or equivalent qualifications) in the Colonial Insecticide Research Unit, Ministry of Supply Chemical Defence Experimental Establishment, Porton, Wiltshire, to conduct research on entomological problems relating to the application of insecticides—The Under-Secretary of State, Research Department (S.610), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Experimental Officers (2) and Assistant Experimental Officers (2) (with qualifications equivalent to pass degree in pure or applied science, and ability to prepare articles describing scientific and technical work in a simple and attractive manner) in the Department of Scientific and Industrial Research, Headquarters Office—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.277/53A.

Graduate (with degree in science, technology or engineering) in the Fuel Technology Section of the Physics Department, to investigate problems associated with heating of steel in industrial furnaces—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "Fuel".

Physicist or Metallurgist (with at least H.S.C. (Science) or equivalent, but degree in metallurgy or physics may be an advantage) at the Atomic Energy Research Establishment, Harwell, for work on X-ray diffraction, involving responsibility for X-ray work of Metallurgy Division—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.289/53A.

Senior Scientific Officer (with first- or second-class honours degree in chemistry or equivalent) in the Mineral Resources Division, Colonial Geological Surveys, Imperial Institute, London, S.W.7, to take part in a special investigation needing a sound knowledge of mineral chemistry and a good general experience of mineral analysis—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.434/53A.

Senior Scientific Officer (with honours degree in mechanical engineering, and preferably with experience in agriculture), as head of section engaged on testing, research and development in connexion with farm mechanization; a Scientific Officer (with honours degree in mechanical engineering) to assist the above S.S.O.; and a Senior Assistant (Scientific) to assist in the maintenance and operation of electronic strain measuring and recording equipment, with the British Society for Research in Agricultural Engineering—The Scottish Machinery Testing Station, Howden, Mid-Calder, Midlothian.

REPORTS and other PUBLICATIONS

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